Chapter 8

Ferrous Metals Production

For the purposes of this report, the ferrous metal industry consists of 28 facilities. These facilities were, as of September 1989, active and reportedly generating one or more of the following special wastes from mineral processing: iron blast furnace slag, iron blast furnace air pollution control dust/sludge, steel open hearth furnace (OHF) or basic oxygen furnace (BOF) slag, and/or steel OHF or BOF air pollution control dust/sludge. Of the 28 reportedly active facilities producing ferrous metals, as indicated in Exhibit 8-1, 24 facilities reported generating both iron and steel wastes at an integrated facility, two reported generating only iron production wastes and two reported generating only steel production wastes. Of the 26 active steel mills, 23 employ basic oxygen furnaces, two employ open hearth furnaces, and one operates both types of steel furnaces.[1] Several iron foundry operations were surveyed but reportedly did not generate any special wastes from mineral processing, and hence, have not been included in this report. The data included in this chapter are discussed in additional detail in the appendices to and the supporting public docket for this report.

8.1 Industry Overview

Iron blast furnaces produce molten iron that can be cast (molded) into products, but is primarily used as the mineral feedstock for steel production. Steel furnaces produce a molten steel that can be cast, forged, rolled, or alloyed in the production of a variety of materials. On a tonnage basis, about nine-tenths of the metal consumed in the United States is iron or steel. Iron and steel are used in the manufacture of transportation vehicles, machinery, pipes and tanks, cans and containers, and the construction of large buildings, roadway superstructures, and bridges.[2]

The 28 ferrous metal facilities are located in ten states; 21 of these facilities are in five states (Ohio, Pennsylvania, Indiana, Illinois, and Michigan) that are situated around the Great Lakes, with immediate access to the lake transport of beneficiated iron ore (taconite pellets). The average age of the iron facilities is approximately forty-six years. The oldest active furnace reportedly is at the US Steel facility in Lorain, Ohio, and is a blast furnace built in 1899 and modernized in 1968. All iron facilities have undergone modernization during the past twenty years; at least 16 of the active facilities performed some modernization during the last 5 years. The average age of the BOFs is twenty-two years, with dates of initial operation ranging from 1958 to 1977; about half of these facilities have undergone modernization. The oldest active OHF operation reportedly commenced operation in 1938; all three of these facilities have been modernized, two within the last three years.

The annual aggregate production capacity of the iron facilities is 72.1 million metric tons; the production was reported to be 49.1 million metric tons, resulting in an estimated average capacity utilization rate of 68.1 percent.[3] The total annual aggregate production capacity was 72.2 million metric tons for the basic oxygen furnaces and about 5.3 million metric tons for the open hearth furnaces.[4] Total production was

---

[1] The ferrous metals sector has, in addition to these 28 primary processing facilities, many secondary processors (e.g., electric arc furnaces, all of which primarily use scrap for feedstock). The Mining Waste Exclusion is limited to facilities that use less than 50 percent scrap as feedstock, thus only steel facilities that do not rely primarily upon scrap as iron feedstock are considered here.

[2] Bureau of Mines, 1985. Mineral Facts and Problems, 1985 Ed., p. 412.

[3] Environmental Protection Agency, 1989. "National Survey of Solid Wastes from Mineral Processing Facilities," 1989.

[4] The average production capacities and utilization rates do not include data from one confidential facility with basic oxygen furnace operations and one confidential facility with open hearth furnace operation.

Exhibit 8-1

Domestic Iron and Steel Producers

Owner	Location	Type of Operation
Acme	Riverdale, IL	Iron;[(a)] BOF Steel
Allegheny	Brackenridge, PA	BOF Steel
Armco	Ashland, KY	Iron; BOF Steel
Armco	Middletown, OH	Iron; BOF Steel
Bethlehem Steel	Bethlehem, PA	Iron; BOF Steel
Bethlehem Steel	Burns Harbor, IN	Iron; BOF, Steel
Bethlehem Steel	Sparrows Point, MD	Iron; BOF, OHF Steel
Geneva	Orem, UT	Iron; OHF Steel
Gulf States Steel	Gadsden, AL	Iron; BOF Steel
Inland Steel	E. Chicago, IN	Iron; BOF Steel
LTV	E. Cleveland, OH	Iron; BOF Steel
LTV	Indiana Harbor, IN	Iron; BOF Steel
LTV	W. Cleveland, OH	Iron; BOF Steel
McLouth Steel	Trenton, MI	Iron; BOF Steel
National Steel	Escore, MI	Iron; BOF Steel
National Steel	Granite City, IL	Iron; BOF Steel
Rouge Steel	Dearborn, MI	Iron; BOF Steel
Sharon Steel	Farrell, PA	Iron; BOF Steel
Shenango	Pittsburgh, PA	Iron
US Steel	Braddock, PA	Iron; BOF Steel
US Steel	Gary, IN	Iron; BOF Steel
US Steel	Fairfield, AL	Iron; BOF Steel
US Steel	Fairless Hills, PA	Iron; OHF Steel
US Steel	Lorain, OH	Iron; BOF Steel
Warren Steel	Warren, OH	Iron; BOF Steel
Weirton Steel	Weirton, WV	Iron; BOF Steel
Wheeling-Pittsburgh Steel	Mingo Junction, OH	Iron; BOF Steel
Wheeling-Pittsburgh Steel	Steubenville, OH	Iron; BOF Steel[(b)]

(a) Acme operates two blast furnaces, labeled A and B, at their Chicago Plant, Chicago, IL as reported in Iron and Steel Maker, Volume 15, No.1; January 1988. They reported, however, no Bevill waste from blast furnace operations in the 1989 "National Survey of Solid Wastes from Mineral Processing Facilities".

(b) Bureau of Mines has indicated that Wheeling-Pittsburgh Steel/Steubenville has a BOF steel operation; the company, however, reported no steel production or generation of special wastes from steelmaking. EPA has assumed no production is presently occuring.

50.2 million metric tons for the basic oxygen furnaces and 2.4 million metric tons for the open hearth furnaces.[5] The estimated 1988 average capacity utilization rate was, therefore, 69.5 percent for the basic oxygen furnaces and 45.3 percent for the open hearth furnaces.[6]

Overall primary production of pig iron was steady through the latter part of the 1980s, while production of raw steel experienced a steady increase. Between 1985 and 1989, primary production of pig iron averaged 46,000,000 metric tons, with almost all production being delivered to steel-making furnaces located at the same site. Imports for consumption and exports of pig iron were negligible during the 1985 to 1989 period. Production of raw steel steadily increased from 74,000,000 metric tons in 1989 to 91,000,000 metric tons in 1988, with a slight decrease of 3,000,000 metric tons in 1989. Imports of steel declined 28 percent (from 23,000,000 metric tons to 17,000,000 metric tons) reflecting the relatively weak dollar and the worldwide strength of the steel market. Due to the same factors, steel exports increased 300 percent (1,000,000 metric tons to 4,000,000 metric tons).[7]

The long-term trend of declining steel-making capacity since 1978 (145,000,000 metric tons) seems to have reversed recently. The capacity, reported by the American Iron and Steel Institute, has increased from 102,000,000 metric tons in 1988 to 104,000,000 metric tons in 1989. Approximately one-half of this increase can be attributed to the start-up of two minimills and reactivation of an inactive minimill. Raw steel production has experienced production levels well above those of the mid 1980s, with steel companies reporting profits for the last three years.[8]

Iron is produced either by blast furnaces or by one of several direct reduction processes; blast furnaces, however, account for over 98 percent of total domestic iron production.[9] The modern blast furnace consists of a refractory-lined steel shaft in which a charge is continuously added to the top through a gas seal. The charge consists primarily of iron ore, sinter, or pellets; coke; and limestone or dolomite. Iron and steel scrap may be added in small amounts. Near the bottom of the furnace, preheated air is blown in. The coke is combusted to produce carbon monoxide, the iron ore is reduced to iron by the carbon monoxide, and the silica and alumina in the ore and coke ash is fluxed with limestone to form a slag that absorbs much of the sulfur from the charge. Molten iron and slag are intermittently tapped from the hearth at the bottom. The slag is drawn off and processed. The product, pig iron, is removed and typically

---

[5] The average production capacities and utilization rates do not include data from one confidential facility with basic oxygen furnace operations and one confidential facility with open hearth furnace operation.

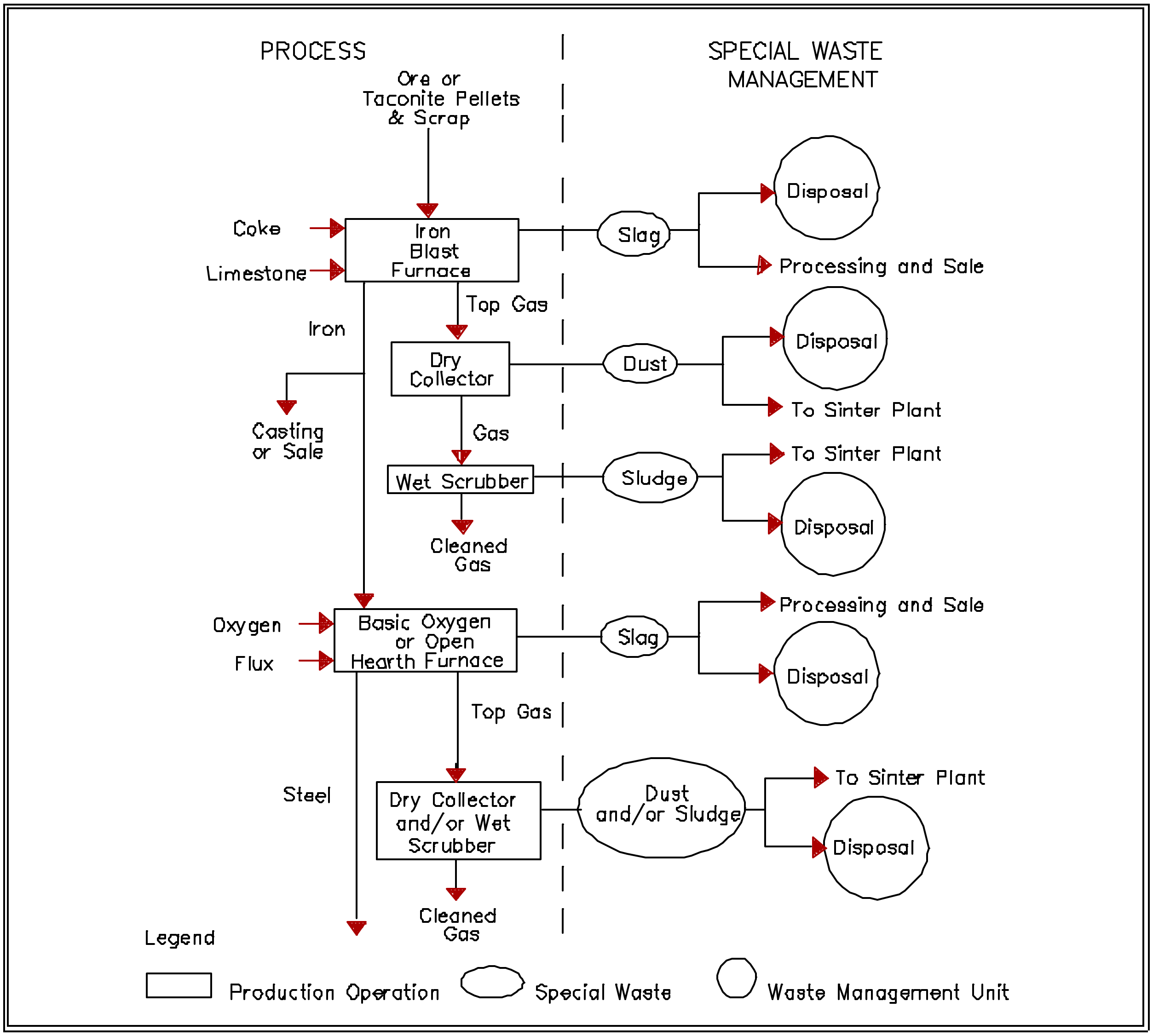
[6] Environmental Protection Agency, 1989. "National Survey of Solid Wastes from Mineral Processing Facilities," 1989.

[7] Anthony T. Peters, U.S. Bureau of Mines, Mineral Commodity Summaries, 1990 Ed., p. 88.

[8] Ibid., p. 88-89.

[9] American Iron and Steel Institute, 1984. "Annual Statistical Report," 1984, p. 78.

Exhibit 8-2
Ferrous Metals Production



cooled, then transported to a steel mill operation, as depicted in Exhibit 8-2.

All contemporary steelmaking processes convert pig iron, scrap, or direct-reduced iron, or mixtures of these, into steel by a refining process that lowers the carbon and silicon content and removes impurities (mainly phosphorus and sulfur). Three major processes are used for making steel, based on different furnace types: the open hearth furnace, accounting for 2-4 percent of total domestic steel production; the basic oxygen furnace, with 56-59 percent of the total; and the electric arc furnace accounting for the remainder. The latter predominantly uses scrap (i.e., non-mineral material) as feed and is not discussed further in this report. The open-hearth process was prevalent in the U.S. between 1908 and

1969, but its use has diminished. The basic oxygen process has supplanted it as the predominant primary steel-making process, currently making up approximately 95 percent of domestic primary steel production.[10]

During the open-hearth process, a relatively shallow bath of metal is heated by a flame that passes over the bath from the burners at one end of the furnace while the hot gases resulting from combustion are pulled out the other end. The heat from the exhaust gas is retained in the exhaust system's brick liners, which are known as checker-brick regenerators. Periodically the direction of the flame is reversed, and air is drawn through what had been the exhaust system; the hot checker-bricks preheat the air before it is used in the combustion in the furnace. Impurities are oxidized during the process and fluxes form a slag; this slag, the special waste, is drawn off and processed or discarded.

The basic oxygen process uses a jet of pure oxygen that is injected into the molten metal by a lance of regulated height in a basic refractory-lined converter. Excess carbon, silicon, and other reactive elements are oxidized during the controlled blows, and fluxes are added to form a slag. This slag, one of the special wastes, is drawn off and processed or discarded.

In all three operations, gases from the furnace must be cleaned in order to meet air pollution control requirements. Facilities may use dry collection or wet scrubbers or, as is most often practiced, both types of controls. Large volumes of dust and scrubber sludge are collected and processed or disposed; these air pollution control residuals are also special wastes.

Based on a review of available data, the Agency believes that the characteristics of the furnace slag from the BOF and OHF processes are similar. Thus, in the remainder of this chapter, no distinction is made between BOF slag and OHF slag; instead, the term "steel furnace slag" is used. For the same reasons APC dusts/sludges from BOFs and OHFs are discussed under the general term "steel furnace APC dust/sludge."

8.2 Waste Characteristics, Generation, and Current Management Practices

Ferrous metal production operations generate four special mineral processing wastes: iron blast furnace slag, iron blast furnace air pollution control dust/sludge, steel furnace slag, and steel furnace air pollution control dust/sludge.

Several comments received by EPA on the rulemaking proposals that established the scope of this report indicated that iron and steel slags should not be considered solid wastes. Based on the information on slag storage, disposal, and utilization presented in this chapter and the definition of solid waste (40 CFR 261.2), some iron and steel slags are solid wastes. EPA recognizes, however, that there may be justification for reconsideration of this position, and will, accordingly, consider comments on this issue. If EPA were to decide that a change is warranted, this change could only be effected through a formal rulemaking process.

Iron Blast Furnace Slag

In 1988, iron blast furnace slag was generated at 26 of the 28 ferrous metal production facilities in the U.S. -- all twenty-four integrated iron/steel facilities and two additional iron blast furnace operations.

Blast furnace slag contains oxides of silicon, aluminum, calcium, and magnesium, along with other trace elements. There are three types of blast furnace slag: air-cooled, granulated, and expanded. Air cooled slag comprises approximately ninety percent of all blast furnace slag produced. The physical characteristics of the slags are in large part determined by the methods used to cool the molten slag. All facilities characterized their slags as solid, though slag is molten at the point of generation.

Non-confidential waste generation rate data were reported for all 26 facilities generating iron blast furnace slag. The aggregate annual industry-wide generation of all iron blast furnace slag by the 26 facilities was 18.8 million metric tons in 1988, yielding a facility average of over 724,000 metric tons per year. Reported facility generation rates ranged from 95,000 to 8.0 million metric tons. The average waste-to-product ratio (i.e., metric ton of iron blast furnace slag to metric ton of pig iron) was 0.384 in 1988.

---

[10] Bureau of Mines, 1987. Minerals Yearbook, Volume I, printed 1989, p. 511.

The primary management practice for iron blast furnace slag is processing (e.g., granulating, expanding, crushing, sizing) and sale for use as aggregate. One facility, as part of a Corp of Engineers approved fill project, deposits its slag in an adjacent water body in order to buildup land area that is intended for use in managing other waste materials.[11]

Using available data on the composition of blast furnace slag, EPA evaluated whether the slag exhibits any of the four characteristics of hazardous waste: corrosivity, reactivity, ignitability, and extraction procedure (EP) toxicity. Based on analyses of 17 samples from eight facilities, the Agency does not believe the slag is corrosive, reactive, ignitable, or EP toxic. Consequently, even in the absence of the regulatory exemption provided by the Mining Waste Exclusion, EPA does not believe that this material would be subject to regulation as a hazardous waste.

Iron Blast Furnace Air Pollution Control (APC) Dust/Sludge

In 1988, iron blast furnace APC dust/sludge was generated at 26 of the 28 ferrous metal facilities in the U.S., including all 24 integrated iron/steel facilities and the two additional iron blast furnace operations.

Air pollution control (APC) devices treat the top gases emitted from iron blast furnaces. The air pollution control devices generate either dusts or sludges. APC dust/sludge is composed primarily of iron, calcium, silicon, magnesium, manganese, and aluminum.

Non-confidential waste generation rate data were reported for all 26 facilities generating iron blast furnace APC dust/sludge. The aggregate annual industry-wide generation of all iron APC dust/sludge by these facilities was approximately 1.2 million metric tons in 1988, yielding a facility average of nearly 52,000 metric tons per year. Reported facility generation rates ranged from 6,000 to 136,000 metric tons. The average waste-to-product ratio (i.e., metric ton of iron blast furnace APC dust/sludge to metric ton of pig iron) was 0.026 in 1988.

As shown in Exhibit 8-3, the two primary waste management practices at the iron facilities regarding APC dust/sludge are disposal in on-site units and the return of the material to the production process via the sinter plant operation or blast furnace.

Using available data on the composition of blast furnace APC dust/sludge, EPA evaluated whether this material exhibits any of the four characteristics of hazardous waste: corrosivity, reactivity, ignitability, and EP toxicity. Based on available information and best professional judgment, the Agency does not believe that the dust/sludge is corrosive, reactive, or ignitable, but some sludge exhibits the characteristic of EP toxicity at some facilities. EP toxicity test concentrations of all eight inorganic constituents with regulatory levels are available for the sludge from 16 facilities. Of these constituents, only selenium and lead concentrations exceeded the EP toxicity levels. Of 64 samples analyzed, concentrations of selenium exceeded the EP toxicity regulatory level in only 1 sample of the blast furnace APC sludge leachate (from the Fairless Hills facility), and in that case, only by a factor of 1.07 (i.e., seven percent over the standard). Lead concentrations exceeded the EP toxicity level in 4 of 70 samples analyzed, and by as much as a factor of 5.8. These 4 samples represented blast furnace APC sludge from the Sparrows Point, E. Cleveland, and Fairless Hills facilities. Lead and selenium concentrations as determined by SPLP analyses did not exceed the EP toxicity regulatory levels. In general, it is not likely that this waste would be regulated as a hazardous waste if it were to be removed from the Mining Waste Exclusion, because it would pass the EP toxicity test (which is best applied using multiple samples and a confidence limit) at most or all facilities.

Steel Furnace Slag

In 1988, steel furnace slag was generated at 26 of the 28 ferrous metal production facilities in the U.S. including all twenty-four integrated iron/steel facilities and two additional steel-producing facilities. Steel slag is composed of calcium silicates and ferrites combined with fused oxides of iron, aluminum, manganese, calcium, and magnesium. At

[11] Bureau of Mines, 1990. Personal Communications with BOM Commodity Specialist, 27 June, 1990.

the point of generation, the slag is in a molten form. The molten slag is air-cooled and is broken into varying sizes once processing (e.g., crushing) begins.

Non-confidential waste generation rate data were reported for 24 of the 26 facilities generating steel furnace slag. The aggregate annual industry-wide generation of all steel furnace slag by these 24 facilities was approximately 13.2 million metric tons in 1988, yielding a facility average of over 553,000 metric tons per year. Reported facility generation rates ranged from 18,000 to 3.3 million metric tons. The average waste-to-product ratio (metric ton of steel slag to metric ton of carbon steel) was 0.253 in 1988, ranging from 0.04 to 1.2.

The primary management practice for steel slag is processing (e.g., crushing, sizing) and sale for use as aggregate, though several facilities dispose or stockpile their steel slag.

Using available data on the composition of steel slag, EPA evaluated whether the slag exhibits any of the four characteristics of hazardous waste: corrosivity, reactivity, ignitability, and EP toxicity. Based on analyses of 13 samples from 9 facilities and best professional judgment, the Agency does not believe the slag is corrosive, reactive, ignitable, or EP toxic. Therefore, this material would be unlikely to be subjected to regulation as a hazardous waste at any facility that generates it, even if it were to be removed from the Mining Waste Exclusion.

Exhibit 8-3
Site-Specific Management of Iron APC Dust/Sludge in 1988

Practice	Number of Facilities	
	APC Dust	APC Sludge
Disposal on-site	6	8
Return to the Sinter Plant	10	6
Return to the Blast Furnace	0	1
Sold	1	1
Off-site management	7	9
Management practice not reported	1	0
Reported not generating waste type	1	1
TOTAL	26	26

Steel Furnace Air Pollution Control (APC) Dust/Sludge

Steel furnace APC dust/sludge is generated at 26 of the 28 ferrous metal production facilities in the U.S., including all 24 integrated iron/steel facilities and the two additional steel producing facilities. Steel APC dust/sludge consists mostly of iron, with smaller amounts of silicon, calcium, and other metals.

Non-confidential waste generation rate data were reported in the SWMPF Survey for only 11 of the 26 facilities generating steel APC dust/sludge. In addition, non-confidential waste generation data were reported by the American Iron and Steel Institute (AISI), a trade association representing the ferrous metals industry; the AISI data were used to supplement the incomplete survey data. Aggregate annual industry-wide generation of all steel APC dust/sludge by the 24 non-confidential facilities was approximately 1.4 million metric tons in 1988, yielding a facility average of nearly 61,000 metric tons per year. Reported facility generation rates ranged from 1,600 to 419,000 metric tons. The average waste-to-product ratio (metric ton of steel APC dust/sludge to metric ton of carbon steel) was 0.028 in 1988.

Waste management practices were reported for only ten of the 26 facilities. Eight of the ten reportedly dispose the APC dust/sludge on-site; the remaining two return the material to the production process via the sinter plant operation.

Using available data on the composition of steel furnace APC dust/sludge, EPA evaluated whether the sludge exhibits any of the four characteristics of hazardous waste: corrosivity, reactivity, ignitability, and EP toxicity. Based on available information and best professional judgment, the Agency does not believe the sludge is corrosive, reactive, or ignitable, but some sludge samples exhibit the characteristic of EP toxicity. EP leach test concentrations of all eight inorganic constituents with EP toxicity regulatory levels are available for the sludge from five facilities of interest. Of these constituents, only selenium concentrations exceeded the EP regulatory levels. Of seven samples analyzed, the concentration of selenium exceeded its regulatory level in only one sample (from the Lorain facility in Ohio), and in this one case, only by a factor of 1.46. Selenium concentrations as determined by SPLP analyses did not exceed the EP toxicity levels. Because selenium rarely exceeds EP toxicity levels when analyzed by the EP leach test, EPA believes that if this material is removed from the Mining Waste Exclusion, it will generally not be subject to regulation as a hazardous waste.

8.3 Potential and Documented Danger to Human Health and the Environment

In this section, EPA discusses two of the study factors required by Section 8002(p) of RCRA for four wastes generated in the ferrous metal production sector: (1) potential risk to human health and the environment associated with the management of iron blast furnace and steel furnace slag and iron blast furnace and steel furnace air pollution control dust/sludge; and (2) documented cases in which danger to human health and/or the environment has been proven. Overall conclusions about the hazards associated with each of these four wastes are based on the Agency's evaluation of these two factors.

Because the characteristics and management of the two slags is similar, EPA discusses them together in the following section, followed by a discussion of the two air pollution control dust/sludges.

8.3.1 Risks Associated With Iron Blast Furnace and Steel Furnace Slag

Any potential danger to human health and the environment from iron blast furnace and steel furnace slag is a function primarily of the composition of the slags, the management practices that are used, and the environmental settings of the facilities where the slags are generated and managed.

Iron Blast Furnace Slag Constituents of Concern

EPA identified chemical constituents in iron blast furnace slag that may pose a risk by collecting data on the composition of slag and evaluating the intrinsic hazard of chemical constituents present in the slag.

Data on Iron Blast Furnace Slag Composition

EPA's characterization of iron blast furnace slag and its leachate is based on data from a 1989 sampling and analysis effort by EPA's Office of Solid Waste (OSW) and industry responses to a RCRA §3007 request in 1989. These data provide information on the concentrations of 21 metals, cyanide, and a number of other inorganic constituents (i.e., chloride, fluoride, phosphorus, and sulfate) in total and leach test analyses, and represent samples from 13 of the 26 facilities that generate blast furnace slag.

Concentrations in total (solid) samples of blast furnace slag are consistent for most constituents across all data sources and facilities. Lead, zinc, and arsenic concentrations, however, vary over three orders of magnitude across the facilities.

Concentrations of constituents from leach test analyses of blast furnace slag generally are consistent across the data sources, types of leach tests (i.e., EP, SPLP, and TCLP), and facilities. Iron concentrations determined by EP analyses, however, are greater than two orders of magnitude higher than concentrations detected by SPLP analysis.

Process for Identifying Constituents of Concern

As discussed in detail in Chapter 2, the Agency evaluated the data summarized above to determine if blast furnace slag or slag leachate contain any chemical constituents that could pose an intrinsic hazard, and to narrow the focus of the risk assessment. The Agency performed this evaluation by first comparing the constituent concentrations to conservative screening criteria and then by evaluating the environmental persistence and mobility of constituents present in concentrations above the criteria. These screening criteria were developed using assumed scenarios that are likely to overestimate the extent to which the slag constituents are released to the environment and migrate to possible exposure points. As a result, this process identifies and eliminates from further consideration those constituents that clearly do not pose a risk.

The Agency used three categories of screening criteria that reflect the potential for hazards to human health, aquatic ecosystems, and water resources (see Exhibit 2-3). Given the conservative (i.e., overly protective) nature of these screening criteria, contaminant concentrations in excess of the criteria should not, in isolation, be interpreted as proof of hazard. Instead, exceedances of the criteria indicate the need to evaluate the potential hazards of the waste in greater detail.

Identified Constituents of Concern

Of the 26 constituents analyzed in blast furnace slag solids, only chromium is present at concentrations exceeding a screening criterion. Chromium was detected at concentrations greater than a screening criterion: it exceeds the inhalation screening criterion in four of twelve slag samples (representing three of seven facilities). The maximum detected concentration of chromium exceeds the air pathway screening criterion by only a factor of six. Chromium concentrations greater than the criterion indicate that the slag could pose a cancer risk greater than $1x10^{-5}$ if slag dust were blown into the air and inhaled in a concentration that equals the National Ambient Air Quality Standard for particulate matter. As discussed in the following section on release, transport, and exposure potential, EPA does not expect such large exposures to windblown dust because of the large particle size of the slag and the large distance to potential receptors.

Exhibit 8-4 presents the results of the comparisons for blast furnace slag leach test analyses to the risk screening criteria. This exhibit lists all constituents for which sample concentrations exceed a screening criterion. As shown, comparison of leach test concentrations of 20 constituents to surface and ground-water pathway screening criteria identified eight contaminants that are present at concentrations above the criteria. All of these contaminants are metals or other inorganics that do not degrade in the environment. Manganese and iron exceed a screening criterion in samples from at least 50 percent of all facilities from which samples were analyzed. These two constituents, as well as lead, arsenic, and silver exceed at least one screening criterion by factors of 10 or greater. The other constituents exceed screening criteria less frequently and by a narrower margin. Previous EPA analyses also indicate that the pH of aqueous extracts of iron blast furnace slag ranges from 5.0 to 11.9 standard units.[12] Leachate data collected as part of the damage cases confirm that leachate from the slag can be very basic (see Section 8.3.3). Despite these exceedances of the screening criteria, none of the samples contained any constituents in excess of the EP toxicity regulatory levels.

These exceedances of the screening criteria indicate the potential for the following types of impacts under the following conditions:

- If slag leachate were released to a potential drinking water supply, and diluted less than tenfold during migration to a drinking water exposure point, long-term ingestion could cause adverse health effects due to the presence of high concentrations of lead, arsenic, and antimony. The concentration of arsenic in diluted slag leachate could pose a lifetime cancer risk of greater than $1x10^{-5}$.
- Lead, aluminum, silver, and mercury in the slag leachate, as well as its alkalinity, could present a threat to aquatic organisms if the leachate migrates (with less than 100-fold dilution) to surface waters.
- Manganese, iron, and lead in the slag leachate, as well its alkalinity, could restrict the potential future uses of affected ground- and surface water resources if released and diluted by a factor of 10 or less.

EPA emphasizes that these exceedances of the screening criteria do not indicate that the slag is actually causing the risks outlined above. Instead, the exceedances provide evidence that the slag could pose these threats under hypothetical, very conservative release and exposure conditions. The actual slag management conditions that influence risks are examined later in this section.

---

[12] EPA. 1979. Environmental and Resource Conservation Considerations of Steel Industry Solid Waste. Office of Research and Development. EPA-600/2-79-074.

Exhibit 8-4
Potential Constituents of Concern in Iron Blast Furnace Slag Leachate[(a)]

Potential Constituents of Concern	No. of Times Constituent Detected/No. of Analyses for Constituent	Screening Criteria[(b)]	No. of Analyses Exceeding Criteria/ No. of Analyses for Constituent	No. of Facilities Exceeding Criteria/ No. of Facilities Analyzed for Constituent
Manganese	6 / 6	Resource Damage	6 / 6	5 / 5
Iron	6 / 6	Resource Damage	4 / 6	3 / 5
Lead	10 / 18	Human Health Resource Damage Aquatic Ecological	5 / 18 7 / 18 2 / 18	2 / 9 3 / 9 2 / 9
Arsenic	4 / 18	Human Health*	4 / 18	1 / 9
Aluminum	6 / 6	Aquatic Ecological	3 / 6	2 / 5
Silver	5 / 18	Aquatic Ecological	3 / 18	2 / 9
Mercury	5 / 18	Aquatic Ecological	1 / 18	1 / 9
Antimony(c)	1 / 6	Human Health	1 / 6	1 / 5

(a) Constituents listed in this table are present in at least one sample from at least one facility at a concentration that exceeds a relevant screening criterion. The conservative screening criteria used in this analysis are listed in Exhibit 2-3. Constituents that were not detected in a given sample were assumed not to be present in the sample. Unless otherwise noted, the constituent concentrations used for this analysis are based on EP leach test results.

(b) Human health screening criteria are based on cancer risk or noncancer health effects. "Human health" screening criteria noted with an "*" are based on a 1×10^{-5} lifetime cancer risk; others are based on noncancer effects.

(c) Data for this constituent are from SPLP leach test results.

Steel Furnace Slag Constituents of Concern

Using the same process outlined above, EPA identified chemical constituents in carbon steel furnace slag that may pose a risk by collecting data on the composition of the slag, and evaluating the intrinsic hazard of the slag's chemical constituents.

Data on Steel Furnace Slag Composition

EPA's characterization of steel furnace slag and its leachate is based on data from a 1989 sampling and analysis effort by EPA's Office of Solid Waste (OSW) and industry responses to a RCRA §3007 request in 1989. These data provide information on the concentrations of 20 metals, cyanide, ammonia, and a number of other inorganic constituents (i.e., phosphorus, phosphate, sulfate, and fluoride) in total and leach test analyses, and represent samples from 14 of the 26 facilities that generate steel furnace slag.

Concentrations in total (solid) samples of the steel furnace slag are consistent for most constituents across all data sources and facilities. Mercury and silver concentrations, however, vary over three orders of magnitude across the facilities.

Concentrations of constituents from leach test analyses of the steel furnace slag generally are consistent across the data sources and facilities. In the EP analyses, however, arsenic, iron, and manganese concentrations varied over approximately three orders of magnitude across the facilities. For most constituents, maximum EP leach test concentrations are somewhat higher than maximum SPLP leach test concentrations.

Identified Constituents of Concern

Exhibits 8-5 and 8-6 present the results of the comparisons for steel furnace slag solid analyses and leach test analyses, respectively, to the risk screening criteria. These exhibits list all constituents for which sample concentrations exceed a screening criterion.

Of the 24 constituents analyzed in steel furnace slag solids, only chromium, thallium, manganese, arsenic, and nickel are present at concentrations exceeding the screening criteria (see Exhibit 8-5). All of these constituents are metals or other inorganics that do not degrade in the environment. Chromium, thallium, and manganese concentrations exceed the criteria most frequently -- in 57 to 100 percent of the samples and in samples from at least one-half of the facilities analyzed. Maximum concentrations of chromium, thallium, and arsenic exceed screening criteria by factors of greater than 10. All other constituents exceed the criteria by a narrower margin.

- Chromium, thallium, and arsenic concentrations exceed the ingestion criteria. This indicates that, if the slag (or soil contaminated with the slag) is incidentally ingested on a routine basis (e.g., if children are allowed to play on abandoned slag piles), then these constituents may cause adverse health effects. The concentration of arsenic in the slag could pose a lifetime cancer risk exceeding $1x10^{-5}$ if incidentally ingested.

- Chromium, manganese, arsenic, and nickel concentrations exceed the health-based screening criteria for inhalation. This indicates that these constituents could cause adverse effects on the central nervous system (manganese) or pose a cancer risk greater than $1x10^{-5}$ (chromium, arsenic, and nickel) if slag dust were blown into the air and inhaled in a concentration that equals the National Ambient Air Quality Standard for particulate matter. Based on the large particle size of the slag and the large distance to potential receptors, however, EPA does not expect such large exposures to windblown dust (as discussed in the next section).

Based on a comparison of leach test concentrations of 23 constituents to surface and ground-water pathway screening criteria (see Exhibit 8-6), eight contaminants in the slag leachate were detected in concentrations above the criteria. All of these contaminants are metals or other inorganics that do not degrade in the environment. Manganese, fluoride, arsenic, and lead concentrations in samples from at least 30 percent of the facilities analyzed exceed screening criteria. Maximum concentrations of manganese, arsenic, and iron exceed screening criteria by factors of more than 10. Leachate data collected during the damage case investigation (see Section 8.3.3) also indicate that the slag leachate can be very basic. However, no constituents were measured in the leachate in concentrations that exceed the EP toxicity regulatory levels.

These exceedances of the screening criteria indicate the potential for the following types of impacts under the following conditions:

- Concentrations of fluoride, arsenic, lead, and barium in steel furnace slag leachate exceed health risk (drinking water) screening criteria. This indicates that, if slag leachate were released and diluted less than tenfold during migration to a drinking water exposure point, long-term ingestion could cause adverse health effects due to the presence of these constituents. The concentration of arsenic in diluted slag leachate could pose a cancer risk of greater than $1x10^{-5}$.

- Lead and silver in the slag leachate, as well as its alkalinity, could present a threat to aquatic organisms if it migrates (with less than 100-fold dilution) to surface waters.

- Manganese, fluoride, arsenic, lead, iron, molybdenum, and barium in the slag leachate, as well as its alkalinity, could restrict the potential future uses of affected ground- and surface water resources if released and diluted by a factor of 10 or less.

Again, EPA emphasizes that the criteria exceedances outlined above should not be interpreted as proof of hazard, but rather indicate the need to examine the slag's release and exposure conditions in greater detail. The Agency therefore proceeded to the next step of the risk assessment to analyze the actual conditions that exist at the facilities that generate and managed the waste.

Exhibit 8-5
Potential Constituents of Concern in Steel Furnace Slag Solids[(a)]

Potential Constituents of Concern	No. of Times Constituent Detected/No. of Analyses for Constituent	Human Health Screening Criteria[(b)]	No. of Analyses Exceeding Criteria/ No. of Analyses for Constituent	No. of Facilities Exceeding Criteria/ No. of Facilities Analyzed for Constituent
Chromium	12 / 12	Inhalation* Ingestion	12 / 12 1 / 12	7 / 7 1 / 7
Thallium	4 / 7	Ingestion	4 / 7	3 / 6
Manganese	10 / 10	Inhalation	6 / 10	5 / 9
Arsenic	7 / 11	Ingestion* Inhalation*	3 / 11 2 / 11	3 / 8 2 / 8
Nickel	3 / 9	Inhalation	1 / 9	1 / 7

(a) Constituents listed in this table are present in at least one sample from at least one facility at a concentration that exceeds a relevant screening criterion. The conservative screening criteria used in this analysis are listed in Exhibit 2-3. Constituents that were not detected in a given sample were assumed not to be present in the sample.

(b) Human health screening criteria are based on exposure via incidental ingestion and inhalation. Human health effects include cancer risk and noncancer health effects. Screening criteria noted with an "*" are based on a $1x10^{-5}$ lifetime cancer risk; others are based on noncancer effects.

Exhibit 8-6
Potential Constituents of Concern in Steel Furnace Slag Leachate[(a)]

Potential Constituents of Concern	No. of Times Constituent Detected/No. of Analyses for Constituent	Screening Criteria[(b)]	No. of Analyses Exceeding Criteria/ No. of Analyses for Constituent	No. of Facilities Exceeding Criteria/ No. of Facilities Analyzed for Constituent
Manganese	3 / 6	Resource Damage	3 / 6	3 / 5
Fluoride	1 / 1	Human Health Resource Damage	1 / 1 1 / 1	1 / 1 1 / 1
Arsenic[(c)]	3 / 8	Human Health* Resource Damage	3 / 8 1 / 8	2 / 5 1 / 5
Lead	4 / 14	Human Health Resource Damage Aquatic Ecological	3 / 14 4 / 14 3 / 14	3 / 10 3 / 10 3 / 10
Silver	2 / 14	Aquatic Ecological	2 / 14	2 / 10
Iron	3 / 6	Resource Damage	1 / 6	1 / 5
Molybdenum	2 / 8	Resource Damage	1 / 8	1 / 7
Barium	7 / 14	Human Health Resource Damage	1 /14 1 / 14	1 / 10 1 / 10

(a) Constituents listed in this table are present in at least one sample from at least one facility at a concentration that exceeds a relevant screening criterion. The conservative screening criteria used in this analysis are listed in Exhibit 2-3. Constituents that were not detected in a given sample were assumed not to be present in the sample. Unless otherwise noted, the constituent concentrations used for this analysis are based on EP leach test results.

(b) Human health screening criteria are based on cancer risk or noncancer health effects. "Human health" screening criteria noted with an "*" are based on a $1x10^{-5}$ lifetime cancer risk; others are based on noncancer effects.

(c) Data for this constituent are from SPLP leach test results.

Release, Transport, and Exposure Potential

This analysis considers the baseline hazards of blast furnace and steel furnace slag as they were generated and managed at six and seven plants, respectively, in 1988. For this analysis, the Agency did not have sufficient data to assess (1) the hazards of off-site use or disposal of the slags, (2) risks associated with variations in waste management practices or potentially exposed populations in the future, or (3) the hazards of alternative management practices. Alternative practices for the management of blast furnace and steel furnace slag, however, are discussed in Section 8.5.

The Agency evaluated the potential hazards posed by the management of blast furnace and steel furnace slag for only the facilities that provided information on on-site slag management units in their responses to the National Survey of Solid Wastes from Mineral Processing Facilities. Of the 20 facilities that generate blast furnace slag but are not evaluated below, 17 facilities responded that blast furnace slag is sold for processing and subsequent use, and 3 facilities identified on-site management units containing blast furnace slag (a stockpile, a temporary storage unit, and slag pits) but provided no details on the characteristics of these units. Of the 19 facilities that generate steel furnace slag but are not evaluated, one facility identified an on-site management unit containing this slag (i.e., a stockpile) but provided no details on the characteristics of this unit, one facility requested that all information in its survey be held confidential, and the other 17 facilities responded that all of the steel furnace slag that they generated in 1988 was recycled or processed and sold. Because the slag management units described by the facilities the Agency analyzed include both slag pits and stockpiles, such as might be present at the facilities that sell slag for processing and off-site use, EPA expects that the hazards at the facilities that are evaluated reflect the nature of the potential threats posed by blast furnace and steel furnace slag at the other facilities that generate these materials.

Ground-Water Release, Transport, and Exposure Potential

EPA and industry test data discussed above show that several constituents are capable of leaching from blast furnace and steel furnace slag in concentrations above the screening criteria. Considering only those constituents that are relatively mobile in ground water (given the existing slag management practices and expected pH levels of the leachate), blast furnace slag contaminants that pose the primary potential threat are arsenic and mercury, and steel furnace slag constituents that present the greatest potential threat are fluoride, arsenic, and molybdenum. In addition, the high pH of slag leachate conceivably could threaten ground-water resources. Based on an evaluation of management practices, hydrogeologic settings, and current ground-water use patterns, EPA concludes that the potential for ground water release and transport ranges from low to relatively high at the eleven facilities for which management unit information is available. However, the potential for significant exposure to any released contaminants appears low at most of these facilities.

Although their slag management units are not equipped with liners or other engineered controls to restrict releases to ground water, the Geneva, USX/Lorain, LTV/East Cleveland, Rouge, and Inland plants have relatively low ground-water contamination potential.

- Ground-water contamination potential is low at the Geneva, USX/Lorain, and LTV/East Cleveland plants because net ground-water recharge at these locations is moderately low (8 to 15 cm/yr) and aquifers are relatively deep (15 to 23 meters).
- The potential for ground-water contamination at Rouge is low because the uppermost useable aquifer lies beneath a confining layer. This confining layer is known to be an effective barrier because the underlying aquifer is artesian (i.e., it has a hydraulic head higher than the surrounding land surface).
- At the Inland plant, blast furnace slag is deposited in an area along the shore of Lake Michigan. Because slag is placed in the lake, slag constituents can readily be leached by lake waters. Nonetheless, there is little potential for contamination of the underlying ground water because of the large depth to the usable aquifer underlying the facility (21 meters).

At the Geneva plant, downgradient use of ground water may occur at a distance of less than 100 meters from the facility. However, considering the low release potential at this site and the generally low concentrations of contaminants in the leachate, the concentrations at this exposure point are expected to be below levels of concern. At the other plants with low ground-water release potential, the potential for exposure is also low because there are no downgradient private residences or public supply wells within 1.6 km (1 mile) downgradient of the plants.

Ground-water release potential is moderate at USX/Fairless Hills, Sharon, Allegheny, and Warren. Because slag management units at these plants do not have ground-water release controls, infiltrating precipitation (net ground-water recharge at these plants ranges from 15 to 23 cm/yr) can leach slag constituents directly into the subsurface and into ground water that occurs 4 to 6 meters below the land surface. Releases to ground water at all four plants, if not sufficiently diluted, could render affected aquifers unsuitable for potential uses. Any ground-water contamination at the Fairless Hills and Warren plants conceivably could result in drinking water exposures at a residence located 150 meters downgradient of the Fairless Hills facility and a public supply well (serving 160 people) located 460 meters downgradient of the Warren facility. Contaminant concentrations at these exposure points, however, are likely to be below levels of concern.

Slag management at the Bethlehem/Bethlehem and Weirton plants poses a relatively high potential for contaminants to migrate into ground water.

- The landfill used to dispose of steel furnace slag at Bethlehem/Bethlehem is located only 3 meters above ground water and recharge in this area is 23 cm/yr.
- At Weirton, blast furnace slag is cooled with water in pits that are lined with recompacted local clay and steel furnace slag is stored in a slag pile that has no ground-water release controls such as a liner or leachate collection system. The clay liner at the blast furnace slag pit may limit the potential for slag cooling water to seep from these pits to the subsurface, but if this liner should fail, releases could migrate through the sandy subsurface materials to the usable aquifer located just over 3 meters (10 feet) below the bottom of the pits.

Despite these unfavorable conditions, no ground-water contamination attributable to the slag management units at these sites has been observed. If such contamination were to occur in the future, it could render ground water unsuitable for potential uses but would not threaten current human populations because there are no downgradient wells within 1.6 km (1 mile) of either facility.

Surface Water Release, Transport, and Exposure Potential

In theory, constituents of potential concern in blast furnace and steel furnace slag could enter surface waters by migration of slag leachate through ground water that discharges to surface water, or direct overland (stormwater) run-off of dissolved or suspended slag materials. The constituent concentrations and pH levels detected in blast furnace and steel furnace slag leachate confirm that the potential exists for slag contaminants to migrate into surface water in a leached form. The potential for overland release of slag particles to surface waters is limited considerably by the generally large size of the slag fragments. A small fraction of the slag material, however, may consist of fragments that are small enough to be erodible. Only particles that are 0.1 mm or less in size tend to be appreciably erodible,[13] and only a very small fraction of the blast furnace and steel furnace slag solids are expected to be in this size range.

Based on environmental settings of the facilities and the presence of stormwater run-on/run-off controls at slag management units, the potential for contaminants from blast furnace and steel furnace slag to migrate into surface water at the eleven facilities appears to range from relatively low to relatively high. The potential for significant exposure to these contaminants, however, appears moderate at most.

The slag stockpile at Geneva has a relatively low potential for causing surface water contamination. Overland releases from this facility are limited by stormwater run-off controls and ground-water releases are limited by the large depth to the aquifer and small net recharge.

Slag management units at Allegheny, Weirton, and Bethlehem/Bethlehem pose a moderate threat to surface waters. The units at these facilities have a limited potential for causing surface water contamination via overland flow

---

[13] As indicated by the soil erodibility factor of the USDA's Universal Soil Loss Equation.

of erodible slag particles or leached slag constituents because the piles and pits at these facilities are equipped with run-off controls. However, as discussed above, the potential for ground-water contamination from the slag management units at these plants is moderate to high, and potential ground-water contaminants may discharge to the surface waters that are within 50 meters of the facilities. Furthermore, the Weirton and Bethlehem/Bethlehem facilities are located in 100-year floodplains and, therefore, are susceptible to severe erosion that might occur in the event of a flood. Even if contamination from the slag management units at these facilities did reach the nearby Allegheny, Ohio, and Lehigh rivers, the contaminants would likely be diluted below levels of concern in the rivers' large flow (the annual average flow of these rivers ranges from 1,400 mgd to 22,000 mgd).

Slag management units at the other seven facilities have a relatively high potential to contaminate surface waters. The USX/Fairless, Inland, Rouge, Sharon, LTV/East Cleveland, Warren, and USX/Lorain facilities are all located adjacent to or very near surface waters and have no controls to limit ground-water infiltration or stormwater run-off. The potential risks posed by releases from these plants depends on the size and current uses of the receiving water bodies.

- The Rouge, LTV/East Cleveland, and USX/Lorain plants pose moderate to low human health risks because contaminants from these facilities could enter rivers with moderate to relatively large flows (i.e., 145 to 580 mgd) that are used as drinking water supplies. The potential for adverse effects is highest at Rouge because the Rouge River has the smallest flow and is used as a drinking water supply for 1.2 million people (intake is 10 km downstream). The Cuyahoga and Black rivers near LTV/East Cleveland and USX/Lorain are larger than the Rouge River, but also used as a drinking water supply within 24 km downstream.
- Releases from the Sharon and Warren plants could potentially enter the Shenango and Mahoning rivers, respectively, where they would be diluted (the rivers' annual average flows are 430 and 580 mgd, respectively). If the contamination was not sufficiently diluted, it could endanger aquatic life and potential consumptive uses of the river water.
- Slag management units at USX/Fairless Hills and Inland are located adjacent to (or in) large water bodies (i.e., the Delaware River and Lake Michigan) that can assimilate large quantities of contaminants. Therefore, it is unlikely that releases from these facilities would adversely affect aquatic life or potential uses of these water bodies.

Air Release, Transport, and Exposure Potential

Because all of the constituents that exceed the inhalation screening criteria (i.e., chromium, manganese, arsenic, and nickel) are nonvolatile, blast furnace and steel furnace slag contaminants can only be released to air in the form of dust particles. Dust can be either blown into the air by wind or suspended in air by slag dumping and crushing operations. Factors that affect the potential for such airborne releases include the particle size of the slag, the height and exposed surface area of the slag management units, the slag moisture content, the use of dust suppression controls, and local wind speeds. The potential for exposure to airborne dust depends on the proximity to nearby residences.

The generally large size of blast furnace and steel furnace slag fragments limits the potential for release of airborne slag dust, because in general, only particles that are less than 100 micrometers (um) in diameter are wind suspendable and transportable. Within this range, moreover, only particles that are less than 30 um in diameter can be transported for considerable distances downwind, and only particles that are less than 10 um in diameter are respirable. The vast majority of blast furnace and steel furnace slag is substantially larger than 100 um and thus should not be suspendable, transportable, or respirable. It is likely that only a very small fraction of the slag will be weathered and aged (or crushed) into smaller particles that can be suspended in air and cause airborne exposures and related impacts.

Other factors that affect the potential for airborne release and exposure vary on a site-specific basis as follows:

- Dust suppression is practiced at the slag management units at Geneva, Allegheny, and Warren. However, because winds are sufficiently strong, if this control is not effective or is discontinued, small slag particles could be suspended and pose health risks at residences located within 100 meters of the facilities. The 1,500; 5,000; and 20,000 residents within 1.6 km (1 mile) of the Geneva, Allegheny, and Warren facilities, respectively, might then be exposed to airborne slag particles.

- Weirton and Rouge manage slag in small units (i.e., .04 to .46 acres) that are not equipped with dust controls. The small size of these units and the generally large size of slag fragments limit the potential for slag to become airborne and be respired. In the event that small slag particles are released to the air, exposures and associated risks would be higher at the Weirton facility than at Rouge because of the differences in distance to the nearest residence (25 m and 275 m, respectively) and the size of the nearby populations (15,000 and 12,000 people within 1.6 km (1 mile), respectively).

- At the USX/Fairless, Inland, Sharon, USX/Lorain, Bethlehem/Bethlehem, and LTV/East Cleveland facilities, the slag management units range from approximately .4 to 140 hectares (1 to 348 acres) in area. These units are not covered with either vegetation or a synthetic material, and the facilities do not use any dust suppression controls, such as sprinkling water on the units. However, the number of days with rain, which may suppress dust, is relatively large (95 to 160 days/yr). As a result, the surface of the slag is expected to be moist much of the time. Short term gusts of strong winds could produce wind erosion of fine particles. Based on these factors, the potential for dusting is moderate at all seven facilities. Windblown dust could lead to potential exposures at these facilities because the nearest residence in a predominant wind direction is less than 700 meters away and the population within 1.6 km (1 mile) ranges from 2,000 to 35,000.

Proximity to Sensitive Environments

Twenty-three of the 26 iron production facilities, and 21 of 26 steel production facilities are located in or near environments that are vulnerable or that have high resource value, such as wetlands, 100-year floodplains, fault zones, national forests, or endangered species habitats. In particular:

- The Geneva facility is located near the critical habitat of a federally listed endangered species -- the June Sucker. Because the critical habitat of this fish is upstream (in the Provo River) from the facility, it is unlikely that releases of waste constituents from the Geneva plant could threaten this habitat.

- Warren, Weirton, USX/Lorain, Shenango (iron only), LTV/East Cleveland, WP/Steubenville (iron only), W-P/Mingo Junction, National/Great Lakes, Bethlehem/Bethlehem, Rouge, Bethlehem/Sparrows Point, USX/Fairless Hills, Gulf States, National/Granite City, and USX/Braddock all have part of their facilities located within 100-year floodplains. Management of wastes in floodplains creates the potential for large, episodic releases caused by flood events.

- USX/Lorain, Bethlehem/Sparrows Point, and USX/Fairless Hills have wetlands (defined here to include swamps, marshes, bogs, and other similar areas) within their facility boundaries. Bethlehem/Burns Harbor, Inland, LTV/East Cleveland, LTV/Indiana Harbor, McLouth, USX/Gary, and Geneva are located within 1.6 km (1 mile) of wetlands. Wetlands are commonly entitled to special protection because they provide habitats for many forms of wildlife, purify natural water, provide flood and storm damage protection, and afford a number of other benefits. Contamination from these sites could potentially cause adverse effects in adjacent or nearby wetlands.

- Bethlehem/Bethlehem and USX/Fairless Hills are located in an area of karst terrain characterized by sink holes and underground cavities developed by the action of water in soluble rock (such as limestone or dolomite). Solution cavities that may exist in the bedrock at this site could permit any ground-water contamination originating from the wastes to migrate in a largely unattenuated and undiluted fashion.

- USX/Fairfield and ARMCO/Ashland are located in fault zones. Any waste containment systems in fault zones are subject to episodic damages caused by earthquakes.

- Bethlehem/Burns Harbor is located within 1.6 km (1 mile) of a National Park. The air and water resources of the National Park potentially could be adversely affected by nearby waste management, and recreational activities at the park could allow exposures to waste constituents released from the nearby ferrous metal production facility.

8.3.2 Risks Associated With Iron Blast Furnace and Steel Furnace Air Pollution Control Dust/Sludge

Any potential danger to human health and the environment from iron blast furnace and steel furnace air pollution control (APC) dust/sludge is a function primarily of the composition of the wastes, the management practices that are used, and the environmental settings of the facilities where the wastes are generated and managed.

Blast Furnace APC Dust/Sludge Constituents of Concern

Using the same process outlined above for blast furnace slag, EPA identified chemical constituents in the blast furnace APC dust/sludge that may pose a risk by collecting data on the composition of the waste, and evaluating the intrinsic hazard of the waste's chemical constituents.

Data on Iron Blast Furnace APC Dust/Sludge Composition

EPA's characterization of blast furnace APC dust/sludge and its leachate is based on data from a 1989 sampling and analysis effort by EPA's Office of Solid Waste and industry responses to a RCRA §3007 request in 1989. These data provide information on the concentrations of 20 metals, cyanide, ammonia, and a number of other inorganic constituents (e.g., phosphorus, phosphate, fluoride, and sulfate) in total and leach test analyses, and represent samples from 17 of the 26 facilities that generate blast furnace APC dust/sludge.

Concentrations in total (solid) samples of the blast furnace APC dust/sludge are consistent for most constituents across all data sources and facilities. Arsenic, mercury, nickel, and selenium concentrations, however, vary over three orders of magnitude across the facilities.

Concentrations of many constituents from leach test analyses of blast furnace APC dust/sludge generally are consistent across the data sources and facilities. In the EP analyses, however, barium, cadmium, chromium, copper, cyanide, lead, and selenium concentrations vary over approximately three orders of magnitude across the facilities. Concentrations of many constituents are higher in EP leach test results than in either SPLP or TCLP test results. EP test concentrations of cadmium, copper, and iron are more than two orders of magnitude higher than the highest concentrations of these constituents in SPLP or TCLP results.

Identified Constituents of Concern

Exhibits 8-7 and 8-8 present the results of the comparisons for blast furnace APC dust/sludge solid analyses and leach test analyses, respectively, to the risk screening criteria. These exhibits list all constituents for which sample concentrations exceed a screening criterion.

Exhibit 8-7
Potential Constituents of Concern in Blast Furnace APC Dust/Sludge Solids[a]

Potential Constituents of Concern	No. of Times Constituent Detected/No. of Analyses for Constituent	Human Health Screening Criteria[b]	No. of Analyses Exceeding Criteria/ No. of Analyses for Constituent	No. of Facilities Exceeding Criteria/ No. of Facilities Analyzed for Constituent
Chromium	43 / 46	Inhalation*	43 / 46	13 / 13
Lead	46 / 47	Ingestion	23 / 47	11 / 14
Arsenic	15 / 36	Ingestion* Inhalation*	12 / 36 3 / 36	5 / 12 2 / 12
Antimony	6 / 9	Ingestion	1 / 9	1 / 7
Cadmium	27 / 44	Inhalation*	2 / 44	1 / 12

(a) Constituents listed in this table are present in at least one sample from at least one facility at a concentration that exceeds a relevant screening criterion. The conservative screening criteria used in this analysis are listed in Exhibit 2-3. Constituents that were not detected in a given sample were assumed not to be present in the sample.

(b) Human health screening criteria are based on exposure via incidental ingestion and inhalation. Human health effects include cancer risk and noncancer health effects. Screening criteria noted with an "*" are based on a 1x10^{-5} lifetime cancer risk; others are based on noncancer effects.

Of the 25 constituents analyzed in blast furnace APC dust/sludge solids, only chromium, lead, arsenic, antimony, and cadmium are present at concentrations exceeding the screening criteria (see Exhibit 8-7). Among these constituents, chromium and lead exceed the criteria most frequently -- in 51 to 93 percent of the samples analyzed and in samples from at least 11 of 14 facilities. Only chromium and antimony are present in concentrations greater than 10 times a screening criterion. All of these constituents are metals or other inorganics that do not degrade in the environment.

- Lead, arsenic, and antimony concentrations exceed the ingestion criteria. This indicates that, if the dust/sludge (or soil contaminated with the waste) is incidentally ingested on a routine basis (e.g., if children are allowed to play on abandoned waste piles), then these constituents may cause adverse health effects. The concentration of arsenic in the dust/sludge could pose a lifetime cancer risk greater than 1x10^{-5} if incidentally ingested on a routine basis.

- Chromium, arsenic, and cadmium concentrations exceed the health-based screening criteria for inhalation. This indicates that these constituents could pose a cancer risk greater than 1x10^{-5} if the dust were blown into the air and inhaled in a concentration that equals the National Ambient Air Quality Standard for particulate matter.

Based on a comparison of leach test concentrations of 23 constituents to surface and ground-water pathway screening criteria (see Exhibit 8-8), 17 contaminants were detected at levels above the criteria. All of these constituents are persistent in the environment (i.e., they do not degrade). Manganese, lead, arsenic, aluminum, iron, zinc, and fluoride exceed at least one screening criterion in samples from at least 50 percent of all facilities at which they were analyzed. Although their concentrations exceed screening criteria less frequently, copper, mercury, and thallium concentrations are more than 40 times higher than the screening criteria. The only constituents that were detected in concentrations above the EP toxicity regulatory levels, however, were lead (in 4 of 70 samples) and selenium (in 1 of 64 samples). In addition, previous EPA analyses indicate that the pH of the aqueous fraction of the dust/sludge ranges from 9.5 to 11.7 standard units.[14]

[14] EPA. 1979. Environmental and Resource Conservation Considerations of Steel Industry Solid Waste. Office of Research and Development. EPA-600/2-79-074.

Exhibit 8-8
Potential Constituents of Concern in Blast Furnace APC Dust/Sludge Leachate[(a)]

Potential Constituents of Concern	No. of Times Constituent Detected/No. of Analyses for Constituent	Screening Criteria[(b)]	No. of Analyses Exceeding Criteria/ No. of Analyses for Constituent	No. of Facilities Exceeding Criteria/ No. of Facilities Analyzed for Constituent
Manganese	6 / 6	Resource Damage	1 / 6	5 / 5
Lead	47 / 72	Human Health Resource Damage Aquatic Ecological	25 / 72 45 / 72 18 / 72	13 / 16 14 / 16 9 / 16
Arsenic	31 / 71	Human Health*	29 / 71	8 / 16
Aluminum	6 / 6	Aquatic Ecological	5 / 6	5 / 5
Iron	11 / 12	Resource Damage Aquatic Ecological	11 / 12 4 / 12	7 / 7 2 / 7
Zinc	27 / 31	Human Health Resource Damage Aquatic Ecological	3 / 31 3 / 31 17 / 31	2 / 11 2 / 11 10 / 11
Fluoride	5 / 5	Human Health Resource Damage	3 / 5 3 / 5	1 / 2 1 / 2
Selenium	19 / 66	Resource Damage Aquatic Ecological	4 / 66 1 / 66	4 / 15 1 / 15
Thallium	2 / 8	Human Health	2 / 8	1 / 6
Mercury	16 / 70	Aquatic Ecological	3 / 70	3 / 15
Silver	23 / 59	Aquatic Ecological	14 / 59	7 / 15
Copper	22 / 34	Aquatic Ecological	4 / 34	2 / 9
Antimony	5 / 13	Human Health	3 / 13	2 / 7
Cadmium	39 / 72	Human Health Resource Damage Aquatic Ecological	2 / 72 4 / 72 3 / 72	2 / 16 4 / 16 3 / 16
Chromium	39 / 72	Resource Damage Aquatic Ecological	3 / 72 1 / 72	2 / 16 1 / 16
Barium	50 / 71	Resource Damage	2 / 71	1 / 15
Nickel	18 / 25	Aquatic Ecological	1 / 25	1 / 10

(a) Constituents listed in this table are present in at least one sample from at least one facility at a concentration that exceeds a relevant screening criterion. The conservative screening criteria used in this analysis are listed in Exhibit 2-3. Constituents that were not detected in a given sample were assumed not to be present in the sample. The constituent concentrations used for this analysis are based on EP leach test results.

(b) Human health screening criteria are based on cancer risk or noncancer health effects. "Human health" screening criteria noted with an "*" are based on a 1×10^{-5} lifetime cancer risk; others are based on noncancer effects.

While this pH is well above the drinking water maximum contaminant level and the ambient water quality criterion for the protection of aquatic life, it does not exceed the limits used to define a corrosive hazardous waste. These exceedances of the screening criteria indicate the potential for the following types of impacts under the following conditions:

- Concentrations of lead, arsenic, zinc, fluoride, thallium, antimony, and cadmium in blast furnace APC dust/sludge leachate exceed health risk (drinking water) screening criteria. This indicates that, if leachate from this waste were released and diluted by only a factor of 10 during migration to a drinking water exposure point, long-term ingestion could cause adverse health effects due to the presence of these constituents. The concentration of arsenic in diluted dust/sludge leachate could pose a cancer risk of greater than $1x10^{-5.}$
- Lead, aluminum, iron, zinc, selenium, mercury, silver, copper, cadmium, chromium, and nickel in the dust/sludge leachate, as well as its alkalinity, could present a threat to aquatic organisms if it migrates (with less than 100-fold dilution) to surface waters.
- Manganese, lead, iron, zinc, fluoride, selenium, cadmium, chromium, and barium in the APC dust/sludge leachate, as well as its alkalinity, could restrict the potential future uses of affected ground- and surface water resources if released and diluted by a factor of 10 or less.

These exceedances of the screening criteria, by themselves, do not demonstrate that the dust/sludge poses a significant risk, but rather indicate that the waste could pose a risk under a very conservative, hypothetical set of release, transport, and exposure conditions. To determine the potential for the dust/sludge to cause significant impacts, EPA proceeded to the next step of the risk assessment to analyze the actual conditions that exist at the facilities that generate and manage the waste (see the following section on release, transport, and exposure potential).

Steel Furnace APC Dust/Sludge Constituents of Concern

Using the same process outlined above for the other three special wastes from ferrous metals production, EPA identified chemical constituents in the steel furnace APC dust/sludge that may pose a risk by collecting data on the composition of the waste, and evaluating the intrinsic hazard of the waste's chemical constituents.

Data on Steel Furnace APC Dust/Sludge Composition

EPA's characterization of steel furnace APC dust/sludge and its leachate is based on data from a 1989 sampling and analysis effort by EPA's Office of Solid Waste and industry responses to a RCRA §3007 request. These data provide information on the concentrations of 20 metals, chloride, and sulfate in total and leach test analyses, and represent samples from 6 of the 26 facilities that generate steel furnace APC dust/sludge.

Concentrations in total (solid) samples of the steel furnace APC dust/sludge are consistent for most constituents across all data sources and facilities. Sulfate and zinc concentrations, however, vary over more than two orders of magnitude across the facilities.

Concentrations of constituents from leach test analyses of the steel furnace APC dust/sludge generally are consistent across the data sources and facilities. In the EP analyses, however, iron and zinc concentrations vary over approximately three orders of magnitude across the facilities. For most constituents, EP leach test results are somewhat higher than SPLP test results. Maximum EP leach test concentrations of iron, manganese, and zinc are more than two orders of magnitude higher than concentrations of the constituents reported for SPLP analyses.

Identified Constituents of Concern

Exhibits 8-9 and 8-10 present the results of the comparisons for steel furnace APC dust/sludge analyses and leach test analyses, respectively, to the risk screening criteria. These exhibits list all constituents for which sample concentrations exceed a screening criterion.

From the 22 constituents analyzed in steel furnace APC dust/sludge solids, only chromium, lead, thallium, antimony, and arsenic are present at concentrations exceeding the screening criteria (see Exhibit 8-9). For all of these constituents except arsenic, concentrations detected in most samples analyzed (57 to 100 percent) exceed screening criteria, and concentrations in samples from at least two facilities exceed screening criteria. Maximum concentrations of chromium, thallium, and arsenic exceed screening criteria by a factor of more than 15. All of these constituents are metals or other inorganics that do not degrade in the environment.

- Lead, thallium, antimony, and arsenic concentrations exceed the ingestion criteria. This indicates that, if the dust/sludge (or soil contaminated with the waste) is incidentally ingested on a routine basis (e.g., if children are allowed to play on abandoned waste piles) these constituents may cause adverse health effects. The concentration of arsenic in the waste would pose a lifetime cancer risk greater than $1x10^{-5}$ if incidentally ingested.

- Chromium and arsenic concentrations exceed the health-based screening criteria for inhalation. This indicates that these constituents could pose a cancer risk greater than $1x10^{-5}$ if dust were blown into the air and inhaled in a concentration that equals the National Ambient Air Quality Standard for particulate matter.

Exhibit 8-9
Potential Constituents of Concern in Basic Oxygen Furnace APC Dust/Sludge Solids[(a)]

Potential Constituents of Concern	No. of Times Constituent Detected/No. of Analyses for Constituent	Human Health Screening Criteria[(b)]	No. of Analyses Exceeding Criteria/ No. of Analyses for Constituent	No. of Facilities Exceeding Criteria/ No. of Facilities Analyzed for Constituent
Chromium	8 / 8	Inhalation*	8 / 8	6 / 6
Lead	8 / 8	Ingestion	8 / 8	6 / 6
Thallium	4 / 7	Ingestion	4 / 7	2 / 5
Antimony	7 / 8	Ingestion	5 / 8	3 / 6
Arsenic	1 / 7	Ingestion* Ingestion*	1 / 7 1 / 7	1 / 5 1 / 5

(a) Constituents listed in this table are present in at least one sample from at least one facility at a concentration that exceeds a relevant screening criterion. The conservative screening criteria used in this analysis are listed in Exhibit 2-3. Constituents that were not detected in a given sample were assumed not to be present in the sample.

(b) Human health screening criteria are based on exposure via incidental ingestion and inhalation. Human health effects include cancer risk and noncancer health effects. Screening criteria noted with an "*" are based on a $1x10^{-5}$ lifetime cancer risk; others are based on noncancer effects.

Exhibit 8-10
Potential Constituents of Concern in Basic Oxygen Furnace APC Dust/Sludge Leachate[(a)]

Potential Constituents of Concern	No. of Times Constituent Detected/No. of Analyses for Constituent	Screening Criteria	No. of Analyses Exceeding Criteria/ No. of Analyses for Constituent	No. of Facilities Exceeding Criteria/ No. of Facilities Analyzed for Constituent
Zinc	6 / 7	Human Health Resource Damage Aquatic Ecological	5 / 7 5 / 7 6 / 7	4 / 5 4 / 5 4 / 5
Manganese	7 / 7	Human Health Resource Damage Aquatic Ecological	1 / 7 7 / 7 1 / 7	1 / 5 5 / 5 1 / 5
Cadmium	6 / 8	Human Health Resource Damage Aquatic Ecological	3 / 8 5 / 8 5 / 8	3 / 6 4 / 6 4 / 6
Iron	5 / 7	Resource Damage Aquatic Ecological	3 / 7 1 / 7	3 / 5 1 / 5
Molybdenum[(b)]	3 / 7	Resource Damage	3 / 7	3 / 5
Lead	3 / 8	Human Health Resource Damage Aquatic Ecological	2 / 8 3 / 8 2 / 8	2 / 6 2 / 6 2 / 6
Selenium	1 / 8	Human Health Resource Damage Aquatic Ecological	1 / 8 1 / 8 1 / 8	1 / 6 1 / 6 1 / 6
Mercury	5 / 8	Aquatic Ecological	1 / 8	1 / 6

(a) Constituents listed in this table are present in at least one sample from at least one facility at a concentration that exceeds a relevant screening criterion. The conservative screening criteria used in this analysis are listed in Exhibit 2-3. Constituents that were not detected in a given sample were assumed not to be present in the sample. Unless otherwise noted, the constituent concentrations used for this analysis are based on EP leach test results.

(b) Data for this constituent are from SPLP level test results.

Based on a comparison of leach test concentrations of 20 constituents to surface and ground-water pathway screening criteria (see Exhibit 8-10), eight contaminants were detected at levels above the criteria. All of these constituents are organics that do not degrade in the environment. Zinc, manganese, and cadmium concentrations exceed screening criteria in most (62 to 100 percent) of the analyses, and their concentrations in samples from at least two-thirds of the facilities analyzed exceed screening criteria. Maximum concentrations of manganese and iron exceed screening criteria by factors of greater than 100, and maximum concentrations of zinc, lead, and selenium exceed screening criteria by factors of greater than 10. Despite these exceedances of the screening criteria, only selenium was detected in a concentration that exceeds the EP toxicity regulatory level, and that was only in one sample.

Previous EPA analyses also indicate that the pH of aqueous extracts of steel furnace APC dust/sludge ranges from 5.4 to 12.5 standard units.[15] This range, especially at the high end, is outside the acceptable range established for drinking water and aquatic life protection.

The exceedances of the screening criteria indicate the potential for the following types of impacts under the following conditions:

- Concentrations of zinc, manganese, cadmium, lead, and selenium in steel furnace APC dust/sludge leachate exceed health risk (drinking water) screening criteria. This indicates that, if dust/sludge leachate were released and diluted less than ten-fold during migration to a drinking water exposure point, long-term ingestion could cause adverse health effects due to the presence of these constituents.
- Zinc, manganese, cadmium, iron, lead, selenium, and mercury in the dust/sludge leachate, as well as its alkalinity, could present a threat to aquatic organisms if it migrates (with less than 100-fold dilution) to surface waters.
- Zinc, manganese, cadmium, iron, molybdenum, lead, and selenium in the APC dust/sludge leachate, as well as its alkalinity, could restrict the potential future uses of affected ground- and surface-water resources if released and diluted by a factor of 10 or less.

These exceedances of the screening criteria, by themselves, do not prove that the dusts/sludges pose significant risks, but rather indicate that the wastes could pose a risk under a very conservative, hypothetical set of release, transport, and exposure conditions. To determine the potential for these wastes to cause significant impacts, EPA proceeded to the next step of the risk assessment to analyze the actual conditions that exist at the facilities that generate and manage the wastes.

Release, Transport, and Exposure Potential

This analysis considers the baseline hazards of blast furnace and steel furnace APC dust/sludge as they were generated and managed at 17 plants in 1988. For this analysis, the Agency did not have sufficient data to assess (1) the hazards of off-site use or disposal of the wastes, (2) risks associated with variations in waste management practices or potentially exposed populations in the future, or (3) the hazards of alternative management practices. However, alternative practices for the management of blast furnace and steel furnace APC dust/sludge are discussed in Section 8.5. The hazards of off-site and alternative management practices were also within the scope of the damage case investigation, presented in Section 8.3.3.

The Agency evaluated the potential hazards posed by the management of blast furnace and steel furnace APC dust/sludges for only the facilities that provided information on on-site dust/sludge management units in their responses to the National Survey of Solid Wastes from Mineral Processing Facilities. Of the 11 facilities that generate blast furnace APC dust/sludge but were not evaluated, 5 facilities responded that this waste was sent off-site for disposal, 4 facilities stated that in 1988 all of this waste was recycled to process units, and 2 facilities identified on-site management units containing this waste (i.e., a stockpile and a waste pile) but provided no details on the characteristics of these units. Of the 15 facilities that generate steel furnace APC dust/sludge but were not evaluated, 2 facilities identified on-site management units containing this waste (i.e., a stockpile and a waste pile) but provided no details on the characteristics of these units, one facility requested that all information in its survey be held confidential, and the other 12 facilities did not provide information on the management of steel furnace APC dust/sludge. Because the management units that are evaluated include both disposal units (e.g., landfills and ponds) and temporary storage units (e.g., storage pads and transfer areas), such as might be present at the facilities that recycle the waste or send it off-site for disposal, EPA expects that the hazards at the facilities that are evaluated reflect the diversity and nature of the potential threats posed by blast furnace and steel furnace APC dust/sludge at the other facilities that generate these wastes.

---

[15] EPA. 1979. Environmental and Resource Conservation Considerations of Steel Industry Solid Waste. Office of Research and Development. EPA-600/2-79-074.

Ground-Water Release, Transport, and Exposure Potential

EPA and industry test data discussed above show that several constituents are capable of leaching from blast furnace and steel furnace APC dust/sludge in concentrations that exceed the conservative screening criteria. Considering the existing waste management practices and pH of the leachate, the only constituents in blast furnace APC dust/sludge that are expected to be mobile in ground water if released are arsenic, fluoride, selenium, mercury, cadmium, and chromium. Steel furnace APC dust/sludge contaminants that are expected to be mobile if released include cadmium, molybdenum, selenium, and mercury. In addition, the pH of APC dust/sludge leachate may threaten ground-water resources. Based on an evaluation of management practices, hydrogeologic settings, and current ground-water use patterns, EPA concludes that the potential for ground-water release, transport, and exposure ranges from low to fairly high at the 17 facilities.

The majority of the iron and steel production plants (12 of the 17 facilities evaluated) manage blast furnace and steel furnace APC dust/sludge as a dry material in units such as stockpiles, landfills, waste piles, and transfer areas. Ground-water release potential from these types of units is determined by the infiltration of precipitation through the unit and into the underlying aquifer. Release, transport, and exposure potential at the 12 facilities managing the sludge/dust in dry units varies according to the use of engineered controls that limit infiltration, the nature of the subsurface geology, and the proximity of the management units to potential drinking water exposure locations.

- Although the Rouge waste pile containing blast furnace APC dust/sludge and the dust silo containing steel furnace APC dust/sludge are not equipped with liners or other engineered controls to restrict releases to ground water, the plant has relatively low ground-water contamination potential because the uppermost useable aquifer is protected by an upper confining layer. Because the underlying aquifer is artesian (i.e., it has a hydraulic head higher than the surrounding land surface), this confining layer is clearly an effective barrier to vertical ground-water flow.

- The Shenango plant temporarily stores blast furnace APC dust/sludge on a concrete-lined pad. This pad may limit infiltration to some extent, but because the pad does not have run-on/run-off controls to contain precipitation that falls on the pad or to limit overland flow of stormwater onto the pad, constituents could be released from this pad following precipitation events. Contaminants released from the pad could reach ground water quite readily because net recharge to ground water in this area is relatively high (18 cm/yr) and the aquifer is relatively shallow (3 meters). If contaminants from the dust/sludge were to enter the aquifer, they could pose health risks to existing populations via a public water supply well (serving 3,000 people) located 1,000 meters downgradient from the facility.

- The Warren and Bethlehem/Burns Harbor plants manage the blast furnace and steel furnace dust/sludge in landfills or piles with no engineered controls to limit ground-water infiltration of waste leachate. The potential for contaminant releases to ground water at these plants is moderate because net ground-water recharge is moderate to high (10 to 28 cm/yr) and the aquifers lie 3 to 6 meters below the land surface. Releases from the stockpile at the Warren plant may be limited somewhat by in-situ clay underlying the unit. Any releases that might occur at the Warren plant could endanger human health through drinking water exposures at a public supply well or private residences, located from 460 to 1,100 meters downgradient.

- The remaining eight facilities that manage the blast furnace and steel furnace dust/sludge in only landfills or piles (i.e., McLouth, LTV/East Cleveland, Bethlehem/Bethlehem, Bethlehem/Sparrows Point, USX/Fairfield, Gulf States, Inland, and LTV/West Cleveland) also have moderate to relatively high release potential but pose no current health risk via the ground-water pathway. The management units at these facilities have no engineered ground-water release controls, and the moderate to high net recharge (8 to 20 cm/yr) where these facilities are located indicates a relatively high potential for releases to ground water from dust/sludge management units. However, ground water is not used as a source of drinking water within 1.6 km (1 mile) downgradient of all eight of these facilities. Any significant releases from these units could render ground-water supplies less desirable for use in the future.

Five facilities manage at least some blast furnace and steel furnace APC dust/sludge in impoundments. Three of these facilities (i.e., ARMCO/Middletown, LTV/Indiana Harbor, and National/Granite City) manage dust/sludges in both impoundments and dry units such as landfills and piles, and two facilities (i.e., Geneva and USX/Lorain) manage the wastes in impoundments only. Ground-water release potential from impoundments is a function of the permeability of the material lying between the impoundment and the aquifer, and the hydraulic head provided by standing liquids in the impoundment. Release, transport, and exposure potential at the five facilities that manage the sludge/dust in impoundments varies according to the use of engineered controls designed to limit seepage or infiltration of precipitation, the nature of the subsurface geology, and the proximity of the management units to potential drinking water exposure locations:

- The LTV/Indiana Harbor plant manages blast furnace APC dust/sludge in a sludge storage area, a lagoon, and a landfill. None of these units have engineered ground-water release controls such as liners or leachate collection systems. The potential for releases to ground water from the lagoon is high due to the hydraulic head of the standing water. For the other units, release potential is moderate because net recharge is moderate (10 cm/yr), subsurface materials are comprised primarily of sand, and the usable aquifer lies six meters below the land surface. There are no current uses of ground water within 1.6 km (1 mile) downgradient of this facility. Consequently, potential releases of dust/sludge contaminants would not pose current health risks but could render the ground water unsuitable for potential future uses.

- Ground-water release potential is relatively high at the ARMCO/Middletown plant because the dust/sludge management units (i.e., a landfill, two surface impoundments, and a waste pile) have no engineered ground-water release controls such as liners or leachate collection systems, and although in-situ clay underlies some of the units, the subsurface material is relatively permeable. Potential releases of dust/sludge contaminants from these units could pose a current health risk via drinking water exposures at a residence located 1,100 meters downgradient of the facility.

- Two of four dust/sludge management units at the National/Granite City plant have engineered controls: the flue dust pond is equipped with primary and secondary leachate collection systems, and the landfill has a synthetic liner. Releases from the other two units at this facility (i.e., the stabilization basin and backwash pond) are not controlled by any engineered features, but they may be limited somewhat by in-situ clay. The potential for ground-water releases from these two impoundments (and the flue dust pond and landfill, if the engineered controls should fail) is relatively high because subsurface material at this plant is comprised largely of sand and the aquifer lies only 2.5 meters below the land surface. Any potential ground-water contamination at this plant could restrict potential future uses but would not present a current health threat (i.e., the aquifer is not used as a source of drinking water within 1.6 km [1 mile] downgradient of this plant).

- The potential for releases from impoundments at the Geneva and USX/Lorain plants is relatively high because the management units are not equipped with engineered ground-water release controls and the subsurface material is moderately permeable. If releases were to occur from these units, ground water at both facilities might be rendered unsuitable for future uses, and contaminated ground water at the Geneva facility might also pose health risks from drinking water exposures at residences as close as 90 meters from the facility.

Surface Water Release, Transport, and Exposure Potential

Theoretically, constituents of potential concern in blast furnace and steel furnace APC dust/sludge could enter surface waters by migration of dust/sludge leachate through ground water that discharges to surface water, or by direct overland (stormwater) run-off of dissolved or suspended dust/sludge materials. The presence of several constituents in blast furnace and steel furnace APC dust/sludge leachate in concentrations that exceed the screening criteria confirms that the potential exists for contaminants from these wastes to migrate into surface water in a leached form. The small size of dust/ sludge particles (ranging from less than 0.02 mm up to 2 mm) also indicates a high potential for overland release of these wastes to surface waters. Particles that are 0.1 mm or smaller in size tend to be appreciably erodible[16], and the Agency expects that a significant fraction of the blast furnace and steel furnace APC dust/sludge is in this size range.

Based on environmental settings of the facilities, management unit characteristics, and the presence of stormwater run-on/run-off controls at some of the blast furnace APC dust/sludge management units, the potential for surface water contamination and human exposure due to releases from blast furnace and steel furnace APC dust/sludge at the 17 facilities is as follows:

- The National/Granite City plant poses very little threat to surface water because of the extreme distance (3,300 meters) to the nearest surface water -- the Mississippi River. Contaminants that might enter the surface water after migrating over this great distance would be diluted sufficiently that they would not pose a threat to any potential uses of the water or to aquatic life.
- The ARMCO/Middletown, LTV/West Cleveland, and Geneva plants pose moderate threats to surface water primarily via the discharge of contaminated ground water to surface waters. Transport of dust/sludge constituents to surface waters from units at these facilities may be limited by the relatively large distance (i.e., 240 to 370 meters) to the nearest surface waters, the use of run-off controls to limit stormwater release from some of the units at the ARMCO and LTV plants, and the small likelihood that sludge managed at the bottom of the impoundment in Geneva could be released to surface water via erosion. As discussed above, however, the potential for ground-water contamination at these facilities is moderate to high and ground-water discharging to surface water may pose threats to aquatic life and potential uses of the nearby surface waters. In addition, if not sufficiently diluted, releases from the LTV/West Cleveland plant could contaminate a drinking water intake located 23 km downstream of the plant.
- APC dust/sludge management at the remaining facilities poses a relatively great threat to surface water by both ground-water discharge to surface water and overland erosion of dust/sludge particles. Release potential from these facilities is high because (1) some of the units at these facilities do not have run-off controls to restrict the erosion and overland transport of dust/sludge particles in stormwater and (2) all these facilities are located less than 200 meters from nearby surface waters. The LTV/East Cleveland, Bethlehem/Sparrows Point, Bethlehem/Bethlehem, Shenango, and Rouge plants present additional hazards because they are located in 100-year floodplains and may release large amounts of contaminants to surface waters in flood events. Aquatic life and potential water uses are threatened from releases to surface waters at all of these plants. These risks are greatest at the USX/Fairfield, Gulf States, LTV/East Cleveland, and Rouge facilities where the receiving water bodies are relatively small (i.e., 70 to 600 mgd). Surface water contamination at the Rouge, Bethlehem/Burns Harbor, LTV/Indiana Harbor, and USX/Lorain plants, if not sufficiently diluted, could pose current health threats via drinking water supply intakes located 10 km, 19 km, 4 km, and 0.5 km downstream from these facilities. These intakes provide drinking water for 1.2 million; 230,000; 93,400; and 75,000 people, respectively.

Air Release, Transport, and Exposure Potential

Because all of the constituents of potential concern are nonvolatile, blast furnace and steel furnace APC dust/sludge contaminants can only be released to air in the form of dust particles. Dust can be either blown into the air by wind or suspended in air by waste dumping operations. Factors that affect the potential for such airborne releases include the particle size of the dust/sludge, the height and exposed surface area of the waste management unit, the moisture content of the waste as it is managed, the use of dust suppression controls, and local wind speeds. The potential for exposure to airborne dust depends on the proximity of the waste management units to people.

In general, particles that are less than 0.1 mm in diameter are wind suspendable and transportable. Within this range, however, only particles that are less than 0.03 mm in diameter can be transported for considerable distances

[16] As indicated by the soil erodibility factor of the USDA's Universal Soil Loss Equation.

downwind, and only particles that are less than 0.01 mm in diameter are respirable. A significant portion of APC dust/sludge particles are small enough to be wind suspendable and some fraction of the suspendable particles consists of smaller particles that can be respired. As discussed above, blast furnace dust/sludge contains arsenic, chromium, and cadmium at concentrations that exceed the screening criteria for inhalation.

APC dust/sludge is managed as dry material that is vulnerable to wind erosion at 15 of 17 facilities. Air pathway risks are expected to be minimal at the two facilities (i.e., Geneva and USX/Lorain) that manage APC dust/sludge in impoundments only. Based on consideration of environmental conditions, management unit characteristics, and distance to potential exposure points, the Agency concludes that air pathway release, transport, and exposure potential varies considerably among the 15 facilities that manage APC dust/sludge in dry units such as landfills and piles.

- Six facilities (McLouth, National/Granite City, Gulf States, LTV/East Cleveland, Bethlehem/Sparrows Point, and Rouge) practice dust suppression at all units other than impoundments used to manage blast furnace APC dust/sludge. If dust suppression practices are not effective, or are stopped for any reason, the potential for dust to be released from these units is relatively high because of the large size of the units at some of these facilities (up to 75 acres) and the large number of dry days each year (230 to 270) when APC dust could be released to the atmosphere. If releases occur, there is significant potential for human exposure at nearby residences (15 to 530 meters downwind). The population within 1.6 km (1 mile) of these facilities ranges from 2,000 to 25,000 people.
- Bethlehem/Burns Harbor and Warren practice dust suppression at some of the units used to manage APC dust/sludge. Releases from dry units at these facilities (a total surface area of 9 hectares (21 acres) at Burns Harbor and 1.3 hectares at Warren) could present inhalation risks for residents living as close as 530 and 100 meters from the Burns Harbor and Warren facilities, respectively. A total of 100 people live within 1.6 km (1 mile) of the Burns Harbor plant and 20,000 people live within 1.6 km of the Warren plant, and could be exposed to airborne contaminants released from APC dust/sludge management units that are dry.
- Seven iron and steel production plants (i.e., Shenango, USX/Fairfield, ARMCO, Inland, LTV/West Cleveland, Bethlehem/ Bethlehem, and LTV/Indiana Harbor) do not practice dust suppression at units used to manage APC dust/sludge. Given the large exposed surface areas of these units (0.08 to 140 hectares) and the large number of dry days each year (250 to 270) when APC dust could be released to the air, the potential for releases of contaminants to the air pathway is relatively high at these facilities. Releases of airborne contaminants could pose human health threats to residents living as close as 15 to 400 meters from these facilities. The total population that might be exposed to airborne contaminants within 1.6 km of these facilities ranges from 3,200 to 20,000 people.

Proximity to Sensitive Environments

As discussed in Section 8.3.1 above, 23 of 26 iron production facilities and 21 of 26 steel production facilities are located in or near environments that are vulnerable or environments that have high resource value (see the discussion in Section 8.3.1).

Risk Modeling

Based upon the evaluation of intrinsic hazard and the descriptive analysis of factors that influence risk presented above, and upon a comprehensive review of information on documented damage cases (presented in the next section), EPA has concluded that the potential for blast furnace and steel furnace slag and APC dust/sludge to pose significant risk to human health or the environment, if managed according to current practice, is low at most facilities but moderate to high at others. This conclusion that the risks are low at most facilities is supported by the Agency's modeling results for other mineral processing wastes that appear to pose a greater hazard than the ferrous wastes, as well as the lack of damage cases (as outlined in the next section). Therefore, in accordance with the risk assessment methodology outlined in Chapter 2, the Agency has not conducted a quantitative risk modeling exercise for these wastes. Section 8.3.4 below discusses the basis for the assessment of the hazard of these wastes in more detail.

8.3.3 Damage Cases

The Agency reviewed State and EPA regional files in an effort to document the performance of slag and APC dust/sludge waste management practices at the active iron and steel facilities, as well as at the following inactive facilities:[17]

US Steel (USX)

- National Works, McKeesport, Allegheny County, PA
- West Mifflin Works (Brown's Dump), West Mifflin, Allegheny County, PA
- Taylor Landfill, West Mifflin, Allegheny County, PA
- Vandergrift Plant, Vandergrift, Westmoreland County, PA
- Clairton Works, Clairton, Allegheny County, PA
- Carrie Furnace, Rankin, Allegheny County, PA
- Imperial Works, Oil City, PA
- Homestead (Carrie Furnace), Rankin, PA
- Irvin Plant, West Mifflin, Allegheny County, PA

LTV Steel

- Aliquippa Works (Crows Island/Blacks Run Creek Residual Site) Aliquippa, Beaver County, PA

Bethlehem Steel

- Steelton, PA
- Johnstown, Cambria County, PA
- Riders Disposal Area, East Taylor Township, Cambria County, PA
- Chesterton, IN

The file reviews were combined with interviews with State and EPA regional regulatory staff. Through these case studies, EPA found documented environmental damages associated with the wastes of concern for only one facility, LTV Steel's Aliquippa Works, in Aliquippa, Pennsylvania.

LTV Steel, Aliquippa, Pennsylvania.

The Jones and Laughlin Steel Corporation (J&L, or LTV Steel) Aliquippa Works, also known as Crow Island, is located in Beaver County, Pennsylvania, along the Ohio River. The Aliquippa Works, no longer an operating facility, was shut down in about 1985.[18] When operational, the Aliquippa facility contained both blast furnace and basic oxygen furnace operations.[19] The Aliquippa facility is located in the flood plain of the Ohio River. The average ground elevation (735 ft Mean Sea Level) is about 15 meters (50 feet) above the normal pool elevation of the Ohio River. At least five private drinking water wells are within 0.8 km (1/2 mile) of an on-site landfill.

Documented environmental impacts have occurred in two general areas of the site. The first area is the Black's Run Landfill, which is lined with basic oxygen furnace slag; leachate from this landfill has entered Black's Run Creek.

[17] Facilities are considered inactive for purposes of this report if they are not currently engaged in primary mineral processing.

[18] USEPA, Region III. 1985. Letter to LTV Steel, Aliquippa, Re: Application for Post-Closure Permit, EPA I.D. No. PAD 00 080 5028.

[19] Jones and Laughlin Steel. 1981. Black's Run Disposal Site Facility Description. 8/27/81.

The second area is the Aliquippa Works facility itself. At least a portion of the facility is underlain by blast furnace slag, which has a thickness of 16 meters (52 feet) in some places.[20] This blast furnace slag is contaminating shallow ground water that seeps into surface water.

The Black's Run area has served as a storage and disposal site for over 40 years. In 1980, J&L commenced operation of a RCRA Subtitle C landfill within the Black's Run site for disposal of certain designated hazardous wastes generated by J&L in the iron- and steel-making processes. The primary hazardous waste disposed at Black's Run was and is air pollution-control dust from electric arc steelmaking furnaces at J&L's Cleveland and Pittsburgh Works.[21,22,23]

The disposal cell was lined with multiple layers: a two foot layer of basic oxygen furnace slag, covered with one and one half feet of low permeability flyash, and topped with a three foot layer of slag. The landfill was constructed on a slope, directing leachate downward to be collected and treated at the 'toe' of the slope.[24]

EPA did not find information on concentrations of metals or other toxic pollutants for either area, but information several conventional water quality parameters was available.

Basic Oxygen Furnace Slag

By 1982, Pennsylvania Department of Environmental Regulation (PADER) investigators found indications that leachate from the landfill was discharging into the East Fork of Black's Run Creek, and that a white precipitate had been deposited on the stream bottom downstream of the landfill. The inspector reported that the leachate was apparently not from the electric furnace dust and sludge, but rather from the slag and ash liner.[25] This white deposit, attributed to the slag liner, was noted in 1987 and 1988 as well.[26,27]

The landfill was closed in September 1987, because its slag liner did not meet the revised standards for an operating permit. Closure activities involved regrading, capping with a clay/soil layer, and securing the area with a fence.[28] Monitoring wells were installed around the landfill at depths to monitor both the shallow aquifer and a deeper aquifer.[29]

Samples taken in March 1987 show Black's Run Creek upstream of the landfill at a pH of 8.43, and total dissolved solids (TDS) at 597 mg/l. Downstream of the landfill, the pH of Black's Run was elevated to 12.30 and TDS to 1,925 mg/l. Monitoring well sampling on this same date showed a significant increase in pH from the upgradient shallow well at a mean of 7.71 to the downgradient shallow well at a mean of 9.29, exceeding the National Secondary Drinking Water

---

[20] LTV Steel. 1980. Hydrogeologic Investigation of Number 18 Well Ammonia Contamination, prepared by The Chester Engineers. August, 1980.

[21] LTV Steel, Aliquippa. 1980. General public news release on Black's Run Secure Landfill. 11/20/80.

[22] Jones and Laughlin Steel. 1981. Black's Run Disposal Site Facility Description.

[23] LTV Steel, Aliquippa. 1982. Form filled for PADER: Request for Approval to Treat, Store, or Dispose of a Hazardous or Residual Waste Stream. 8/25/82.

[24] PADER. 1982. Bureau of Solid Waste Management Memo, from S. McDougall to V. Luci. Re: Jones and Laughlin Steel Corporation, Aliquippa Works, Blacks Run Disposal Site, RCRA Well Proposal Review, and General Site Comments. 12/29/82.

[25] Ibid.

[26] PADER. 1987. Bureau of Waste Management, Hazardous Waste Inspection Report, TSD Facilities. LTV Steel Blacks Run Creek Secure Cell, Aliquippa, Beaver County. 11/6/87.

[27] PADER. 1988. Bureau of Solid Waste Management, General Inspection Form. LTV Steel - Blacks Run Creek Residual Site, Aliquippa, PA. 6/2/88.

[28] PADER. 1990. Personal Communication with C. Spadero.

[29] PADER. 1988. Bureau of Waste Management, Comments on closure of LTV Blacks Run site, Aliquippa. (9/23/86 and 7/1/88.)

Regulations maximum pH level of 8.5. Analytical data for parameters other than pH and TDS were not contained in the available documents.[30]

In a June 1988 inspection report, the PADER inspector noted that visible impacts to the Black's Run Creek occurred much farther downstream than when they had been first noted several years previously. The inspector found the creek bottom covered with precipitate for approximately 460 meters (500 yards) downstream. The PADER inspector also stated that little aquatic life was evident in the creek from the point where it passed the landfill until well below all the seeps, close to where the stream goes under Route 51. Another inspector in June 1988 found erosion problems on the soil cap of the closed landfill, and an unsatisfactory revegetation status.[31,32,33]

Blast Furnace Slag

As mentioned previously, the Aliquippa Works facility itself was constructed on blast furnace slag fill, which is at least 16 meters (52 feet) thick in some places.[34,35]

---

[30] LTV Steel. 1987. Letter with attachments to PADER, Re: Black's Run Secure Landfill Groundwater Monitoring Data and Statistical Analysis, Tenth Quarter (1st Quarter, 1987), Aliquippa Works, Aliquippa, PA. 7/24/87.

[31] PADER. 1988. Bureau of Solid Waste Management, General Inspection Form. LTV Steel - Blacks Run Creek Residual Site, Aliquippa, PA. 6/2/88.

[32] PADER. 1988. Bureau of Waste Management, Hazardous Waste Inspection Report, TSD Facilities. LTV Steel Blacks Run Creek Secure Cell, Aliquippa, Beaver County. 6/10/88.

[33] PADER. 1988. Bureau of Waste Management, Comments on closure of LTV Blacks Run site, Aliquippa. (Includes 9/23/86 and 7/1/88.).

[34] LTV Steel. 1980. Hydrogeologic Investigation of Number 18 Well Ammonia Contamination, prepared by The Chester Engineers. 8/80.

[35] LTV Steel. 1988. Letter to USEPA, Region III and PADER, Re: NPDES Permit No. PA 0006114: November, 1988 Monitoring Results. 12/27/88.

In a cover letter for monitoring data submitted by LTV to PADER, LTV discussed elevated pH and TDS values in seep samples, stating that such values "are not unexpected from areas where the slag was placed for fill." Analytical data from these seeps from 1977 through 1985 showed pH values ranging from 12.1 to 13.1, while TDS values ranged from 1370 mg/l to 3508 mg/l.[36]

In a letter to PADER in December 1987, LTV discussed its NPDES violations. LTV reported two outfalls discharging water with pH values of 10.9 and 10.4, exceeding the maximum permitted pH of 9.0. LTV explained that "the fill in the area of the two outfalls is all blast furnace slag. This would cause high pH in rainwater entering the now idled sewers."[37]

LTV's November 1988 NPDES monitoring results submitted to PADER indicated an exceedance of the maximum permitted pH level of 9.0 in an outfall with pH 9.4. LTV again explained that the Aliquippa Works is built on slag fill. LTV noted that since no operating facility uses the sewer of concern, ground water from the slag filled areas was probably infiltrating the sewers and causing the high pH.[38]

8.3.4 Findings Concerning the Hazard Posed by Special Wastes from Ferrous Metals Production

Based upon the detailed examination of the inherent characteristics of iron blast furnace and steel furnace slags and APC dusts/sludges, the management practices that are applied to these wastes, the environmental settings in which the generators of the materials are situated, and the documented environmental damages that have been described above, EPA concludes that these wastes pose a low to moderate risk to human health and the environment.

Blast Furnace and Steel Furnace Slag

Review of the available data on blast furnace and steel furnace slag solid sample and leachate constituent concentrations indicates that only seven constituents are present at concentrations greater than 10 times conservative screening criteria. In blast furnace slag, concentrations of manganese, iron, lead, arsenic, and silver exceed screening criteria by more than a factor of 10. Concentrations of manganese, iron, chromium, thallium, and arsenic in steel furnace slag exceed one or more of the conservative screening criteria by more than a factor of 10. In addition, aqueous extracts of both blast furnace and steel furnace slag are highly alkaline (pH up to 11.7). These exceedances indicate the potential for the slags to pose risks under very conservative, hypothetical exposure conditions. The wastes do not exhibit any of the four characteristics of a hazardous waste, and the actual exposure conditions at the active facilities are not as conducive to human health or environmental damage as those upon which the screening criteria are based. This is largely because the slags consist of large solid fragments that are not readily released and dispersed. This finding leads EPA to conclude that the intrinsic hazard of these slags is low.

Based on a review of the site-specific conditions at 11 facilities, the potential for blast furnace and steel furnace slag to cause significant impacts appears low at most of the active facilities. The potential for significant releases to ground water is often limited by a low net recharge and a large depth to ground water. The potential for significant surface water impacts is limited by the large particle size of the slag (which precludes erosion) as well as the large distances to water bodies, large surface water flow rates, and great downstream distances to potential receptors at many sites. The large particle size of the slag also limits the potential for significant airborne releases. This overall low-risk conclusion is supported by the general lack of documented cases of damage attributable to the slags. Even though the slags have been generated and managed at many sites for several decades, EPA identified only one damage case and

---

[36] LTV Steel. 1985. Letter with attachments to PADER, Re: LTV Steel Company, Inc. (Jones and Laughlin Steel, Inc.) Aliquippa Works - Crow Island Site. 8/27/85.

[37] LTV Steel. 1987. Letter to PADER, Bureau of Water Quality, Re: NPDES Permit PA 0006114, Pollution Reduction Report, LTV Steel Co., Beaver County. 12/2/87.

[38] LTV Steel. 1988. Letter to USEPA, Region III and PADER, Re: NPDES Permit No. PA 0006114: November, 1988 Monitoring Results. 12/27/88.

that case is associated with an inactive facility under rather unusual conditions (i.e., the slag was used as a liner for a hazardous waste landfill). EPA believes that the management controls and environmental conditions at a few of the active facilities are, in theory, also favorable for contaminant releases to ground and surface water, but no releases are known to have occurred at these sites in the past.

Blast Furnace and Steel Furnace APC Dust/Sludge

Review of the available data on blast furnace and steel furnace APC dust/sludge solid samples and leachate concentrations indicates that a number of constituents are present at concentrations that exceed the conservative screening criteria. Concentrations of 12 constituents in blast furnace APC dust/sludge exceed one or more of the conservative screening criteria by more than a factor of 10. In steel furnace APC dust/sludge, manganese, iron, zinc, lead, selenium, chromium, thallium, and antimony concentrations exceed one or more of the conservative screening criteria by more than a factor of 10. In addition, aqueous extracts of both blast furnace and steel furnace APC dust/sludge are highly alkaline (pH up to 12.5). While releases and exposures are generally not expected to be as large as the hypothetical conditions upon which the screening criteria are based, the dusts/sludges consist of small particles that could be released to the environment if not properly controlled. The available data also indicate that some blast furnace APC dust/sludge at some facilities exhibits the characteristic of EP toxicity, but that steel furnace APC sludge probably is not EP toxic (although the selenium concentration in one sample did exceed the regulatory level by a factor of 1.46). As a result, EPA believes that the intrinsic hazard of these wastes is moderate to high.

Based on an examination of the site-specific conditions at 17 facilities, the current management of blast furnace and steel furnace APC dust/sludge poses a low threat at some facilities but a moderate to high threat at others. In general, the potential for the dust/sludge to cause significant ground-water impacts is limited at most sites that manage the waste in a dry form (in stockpiles, landfills, waste piles, etc.) because of the low net recharge, depth to ground water, and/or distance to potential receptors. When managed in impoundments, however, there is a considerably greater potential for the dust/sludge contaminants to migrate into ground water. EPA believes that the potential for dust/sludge contamination to migrate into surface water is high at 13 of the facilities because of the wastes's small particle size, a lack of engineered controls to limit releases, and a close proximity to surface water bodies. However, contaminants entering rivers near all but four of these facilities are likely to be readily assimilated by the rivers' large flow. Considering the susceptibility of the dust/sludge to wind erosion, the exposed surface area of waste management units, the lack of dust suppression controls, atmospheric conditions, and population distributions, there is also a relatively high potential for airborne releases and exposures at seven facilities. Despite these theoretical conclusions about potential hazards, EPA did not identify a single case of environmental degradation that can be attributed to the dust/sludge. Therefore, considering the site-specific conditions together with the lack of damage cases, EPA concludes that the dust/sludge poses an overall moderate risk.

8.4 Existing Federal and State Waste Management Controls

8.4.1 Federal Regulation

Under the Clean Water Act, EPA has the responsibility for setting "effluent limitations," based on the performance capability of treatment technologies. These "technology based limitations" which provide the basis for the minimum requirements of NPDES permits, must be established for various classes of industrial discharges, including a number of mineral processing categories.

Permits for mineral processing facilities may require compliance with effluent guidelines, based on the best practicable control technology currently available (BPT) or best available technology economically achievable (BAT). These limitations do not apply to non-point sources, such as run-off from slag piles, or impoundments containing APC sludges and dusts. BPT effluent limitations (40 CFR 420.32(a)) for discharges of wastewater from iron blast furnace slags include:

Pollutant	Daily Maximum	Monthly Average
Ammonia	0.161 Kg/kkg	0.0537 mg/l
Cyanide	0.0234 mg/l	0.00782 mg/l
Phenols	0.00626 mg/l	0.00210 mg/l

For BAT, the following effluent limitations, found at 40 CFR 420.33(a), apply to discharges from iron blast furnaces:

Pollutant	Daily Maximum	Monthly Average
Ammonia	1.29 mg/l	0.429 mg/l
Cyanide	0.469 mg/l	0.156 mg/l
Phenols	0.0624 mg/l	0.0208 mg/l

The discharge of wastewater pollutants from any new source of iron blast furnace slag may not exceed the following (40 CFR 420.34(a)):

Pollutant	Daily Maximum	Monthly Average
Ammonia	0.00876 mg/l	0.00292 mg/l
Cyanide	0.000584 mg/l	0.000292 mg/l
Phenols	0.0000584 mg/l	0.0000292 mg/l
Lead	0.000263 mg/l	0.0000876 mg/l
Zinc	0.00394 mg/l	0.000131 mg/l

EPA has also established BPT and BAT effluent limitations resulting from steelmaking operations conducted in basic oxygen and open hearth furnaces. BPT effluent limitations allow no discharge from semi-wet BOF steelmaking. BPT limitations for steel-making operations for which wastewater discharges are allowed include (40 CFR 420.42(b),(c)):

BASIC OXYGEN FURNACE - WET-SUPPRESSED COMBUSTION		
Pollutant	Daily Maximum	Monthly Average
Total Suspended Solids	0.0312 Kg/kkg	0.0104 Kg/kkg
pH	6-9	6-9

BASIC OXYGEN FURNACE - WET-SUPPRESSED COMBUSTION AND OPEN HEARTH FURNACE - WET		
Pollutant	Daily Maximum	Monthly Average
Total Suspended Solids	0.0687 Kg/kkg	0.0229 Kg/kkg

pH	6-9	6-9

BAT effluent limitations allow no discharge from semi-wet BOF steelmaking (40 CFR 420.43(a)). BAT limits for wastewater discharges from other processes include (40 CFR 420.43 (b),(c)):

BASIC OXYGEN FURNACE - WET-SUPPRESSED COMBUSTION		
Pollutant	**Daily Maximum**	**Monthly Average**
Lead	0.000188 Kg/kkg	0.0000626 Kg/kkg
Zinc	0.000282 Kg/kkg	0.0000939 Kg/kkg

BASIC OXYGEN FURNACE - WET-SUPPRESSED COMBUSTION AND OPEN HEARTH FURNACE - WET		
Pollutant	**Daily Maximum**	**Monthly Average**
Lead	0.000413 Kg/kkg	0.000138 Kg/kkg
Zinc	0.000620 Kg/kkg	0.000207 Kg/kkg

New source standards for discharges include (40 CFR 420.44 (b),(c)):

BASIC OXYGEN FURNACE - WET-SUPPRESSED COMBUSTION		
Pollutant	**Daily Maximum**	**Monthly Average**
Total Suspended Solids	0.0146 Kg/kkg	0.00522 Kg/kkg
Lead	0.000188 Kg/kkg	0.0000626 Kg/kkg
Zinc	0.000282 Kg/kkg	0.0000939 Kg/kkg
pH	6-9	6-9

BASIC OXYGEN FURNACE - WET-SUPPRESSED COMBUSTION AND OPEN HEARTH FURNACE - WET		
Pollutant	**Daily Maximum**	**Monthly Average**
Total Suspended Solids	0.0321 Kg/kkg	0.0115 Kg/kkg
Lead	0.000413 Kg/kkg	0.000138 Kg/kkg
Zinc	0.000620 Kg/kkg	0.000207 Kg/kkg
pH	6-9	6-9

8.4.2 State Regulation

The 28 facilities generating blast furnaces slag, steel furnace slag, blast furnace APC dust and sludge, and/or steel furnace APC dust and sludge are located in ten states, including Alabama, Illinois, Indiana, Kentucky, Maryland, Michigan, Ohio, Pennsylvania, Utah, and West Virginia. Five of these states, Indiana, Kentucky, Ohio, Pennsylvania, and Utah, were selected for detailed review for the purposes of this report (see Chapter 2 for a discussion of the methodology used to select states for detailed study). Within the five study states, the majority of facilities are located in Ohio (seven), Pennsylvania (six), and Indiana (four). Based on the distribution of facilities within the five study states, state-level regulation of ferrous metal production facility wastes is of particular interest in the States of Ohio and Pennsylvania.

Each of the ten states with one or more ferrous metal production facilities have adopted the federal Mining Waste Exclusion and therefore do not regulate any of the four special wastes from ferrous metal production as hazardous wastes. Three of the five study states, Ohio, Indiana, and Utah, do not regulate iron or steel slag within their solid waste regulations. None of the states appear to regulate slag stored on-site for eventual recycling or reprocessing. APC dust and sludge may be shipped to permitted landfills, although this is not regularly required by state regulation. Limited requirements are imposed on dust and sludge disposed on-site. Requirements for NPDES permits and run-on/run-off controls vary by state and by facility in each state. Similarly, requirements for fugitive dust controls vary by state regulation and facility location. In contrast to the limited nature of current regulatory efforts, Ohio and Indiana recently promulgated new solid waste regulations; Kentucky is finalizing new regulations; Pennsylvania recently proposed new residual waste regulations; and Utah recently passed new ground-water legislation. The increasing regulation of ferrous wastes in each of these states could significantly affect the management of ferrous wastes, particularly APC dust and sludge.

Seven ferrous metal production facilities are located in Ohio. The Ohio Solid Waste Disposal Regulations state that slag is not a waste. The re-use of slag, however, may be subject to certain requirements. Ohio does regulate APC dust and sludge as a solid waste. Facilities generating APC dust and sludge must either obtain a permit to dispose of this waste on-site or ship the waste to a permitted landfill off-site. According to state officials, only one of the seven facilities in the state has a permit for on-site disposal while the remaining facilities either store the dust and sludge indefinitely for recycling or ship it off-site for disposal. State officials were not able to provide details on the final disposition of much of the waste. Regulatory controls of these wastes, until the recent promulgation of new solid waste regulations, appear to have been limited. The recently amended regulations, however, require owners and operators of all landfills, including on-site APC dust and sludge landfills, to apply for a permit and meet a variety of technical criteria (e.g., removal of free liquids, establishment of ground-water monitoring, placement of a final cap, provision of financial assurance). Finally, although NPDES permits are required for discharges to waters of the state and permits are required for landfills with fugitive dust emissions, Ohio does not appear to apply these requirements to ferrous slag piles or surface impoundments.

Ferrous metal production slags and APC dust and sludges are not regulated as either hazardous or solid wastes by Pennsylvania. Instead, the state currently regulates ferrous wastes as "residual wastes." A proposed rule regulating residual wastes would require a substantial expansion in the scope of the management controls for slag and APC dust and sludge. The current residuals rule imposes only limited permitting requirements. For instance, although waste piles used for permanent disposal must be permitted under current state residuals regulations, Pennsylvania effectively has not implemented this requirement for slag piles because of disagreements with industry on the status (i.e., storage versus disposal) of the waste. Similarly, the state applies surface water and air (i.e., fugitive dust control) requirements on ferrous metal production waste management activities on a case-by-case basis and generally in response to complaints or evidence of contamination only. Although the proposed rule would impose notably more stringent environmental controls on the management of ferrous wastes, the final status of these wastes and the exact nature of additional environmental controls will depend on the final rule.

Indiana does not regulate the "legitimate use of iron and steelmaking slags..." Indiana classifies APC dust and sludge, however, as a special waste and requires that waste shipped off-site be sent to a designated landfill meeting the technical criteria for special wastes. Owners and operators disposing of APC dust and sludge on-site were not required to meet special landfill standards until the state modified its regulations in 1989. Three of the four facilities in the state have submitted permit applications to continue on-site disposal, but it is not yet clear what kinds of technical requirements the state may impose in response to these applications. Surface water and air discharge controls are addressed by the state on a facility-specific basis and generally have been limited in scope. The extent of waste management requirements for ferrous wastes remains somewhat unclear because the state's regulatory program implementation efforts have not been completed.

One ferrous metal production facility is located in Kentucky. Kentucky requires some environmental controls (e.g., maintaining a temporary cover, run-on/run-off controls, and drainage ditches) for on-site slag disposal piles, but these requirements do not apply to slag that is reprocessed or sold. The state also requires that the "residential" landfill to which the APC dust and sludge is shipped meet ground-water monitoring criteria. Kentucky imposes effluent discharge limits on all iron and steel plant discharges, and imposes extensive fugitive dust emission controls on slag management activities including watering of slag as it is generated, "quenching" of trucks transporting slag, and transportation of slag on oiled roads. Kentucky recently finalized its solid waste regulations and may impose more stringent environmental controls on the management of slags and APC dusts and sludges at the ferrous facility, although the extent of the requirements cannot be predicted until the regulations are implemented.

The state of Utah also has one ferrous metal production facility. In contrast to Kentucky, however, Utah does not address either ferrous metal production slags or APC dusts and sludges under its solid waste regulations. Utah recently enacted new ground-water legislation which mandates that all ground-water discharges be permitted, though the state has not yet issued such permits. Moreover, although Utah has particulate matter air emissions regulations, it is not clear to what extent controls are required for ferrous waste management (in particular, slag) at this facility.

In summary, ten states generate ferrous metal production slags and/or APC dust and sludges, of which five states were studied in detail for this report. The five study states regulate ferrous metal production wastes similarly in a number of respects. For the most part, iron and steel slag management is currently subject to limited solid waste regulation in these states, although in some cases waste slag is disposed of in a permitted landfill. Although the management and disposal of APC dust and sludge has also been subject to limited regulatory controls, these wastes are landfilled by facilities in several states and thus subject to all pertinent regulations governing landfills in those states. Moreover, APC dust and sludge, as a rule, is regulated more frequently than slag by the five study states. Finally, four of the five study states recently published final or proposed waste regulations, while the fifth state recently enacted new ground-water protection legislation, all of which could affect significantly the kinds and stringency of environmental controls imposed by the states on ferrous metal production waste management and disposal activities.

8.5 Waste Management Alternatives and Potential Utilization

Iron Blast Furnace Slag

As discussed above, EPA does not believe that iron blast furnace slag exhibits any of the four characteristics of hazardous waste (corrosivity, reactivity, ignitability, or EP toxicity). Consequently, the issue of how iron producers might modify their operations, waste management practices, or be stimulated to develop alternative uses for iron slag in response to prospective hazardous waste regulation under RCRA Subtitle C is moot. Any such operational changes that are currently contemplated by facility operators will therefore not be affected by EPA's actions, and hence, are beyond the scope of this Report to Congress. Nonetheless, in the following paragraphs, the Agency provides a brief summary of current and potential areas of utilization.

In 1988, nearly 18.8 million metric tons of iron blast furnace slag were generated by 26 U.S. iron processing facilities.[39] On-site accumulation at the 26 facilities ranges from 0 to 10 million cubic meters (0 to 13 million cubic yards), with a total accumulation of over 14.6 million cubic meters in active waste management units.[40] The facility which has accumulated 10 million cubic meters of slag, Inland Steel in East Chicago, is placing it in Lake Michigan in order to create land on which additional waste can be disposed.[41] Surveys of slag processors nationwide indicate that 14.4 million metric tons of slag were sold and/or used in the United States in 1988 at an average price of $6.97 per ton.[42] Some of this slag was retrieved from slag piles at abandoned facilities.

According to a Bureau of Mines survey, 90 percent (16.9 million metric tons) of the iron blast furnace slag utilized in 1988 was air-cooled. Air-cooled slag was sold at an average price of $4.87 per ton, ranging from an average of $3.29 when sold for use as fill to an average of $9.87 when sold as material for built-up and shingle roofing. Distribution of air-cooled slag among its various applications is shown in Exhibit 8-11.

Exhibit 8-11
Uses of Air-Cooled Iron Blast Furnace Slag[43]

Road base	57%
Concrete aggregate	12%
Fill	10%
Asphaltic concrete aggregate	7%
Railroad ballast, mineral wool, concrete products, glass manufacture, sewage treatment, roofing, and soil conditioning	14%

[39] Company Responses to the "National Survey of Solid Wastes from Mineral Processing Facilities," U.S. EPA, 1989.

[40] Ibid.

[41] Personal communication, Judith F. Owens, Physical Scientist, U.S. Bureau of Mines, Branch of Ferrous Metals, April 24, 1990.

[42] Judith F. Owens, "Slag-Iron and Steel," Minerals Yearbook-1988, U.S. Department of the Interior, Bureau of Mines, 1988, p. 2.

[43] Ibid. p.5

The remaining 10 percent (1.8 million metric tons) of iron blast furnace slag utilized in 1988 was comprised of expanded slag, which is primarily used as a light-weight concrete aggregate, and granulated (water-cooled) slag, most of which is used in the manufacture of Portland cement and other cementitious materials. Of the iron blast furnace slag generated in the U.S., the Bureau of Mines indicates that nearly all of it is eventually utilized.[44]

In the future, most primary iron producers in the U.S. are expected to modernize their blast furnaces and install slag granulation facilities. If such a change does occur, it is likely to result in more slag being used to manufacture Portland cement, and less slag being utilized as aggregate or road base. There has also been some speculation about using iron blast furnace slag to stabilize low-level radioactive wastes, and also in the manufacture of a ceramic-matrix composite material used in interior building applications.[45]

Iron Blast Furnace Air Pollution Control (APC) Dust/Sludge

As discussed above, EPA sampling data indicate that some APC dust/sludge from iron blast furnaces may exhibit the hazardous waste characteristic of EP toxicity at some facilities. Accordingly, the Agency has conducted an intensive literature review of potential waste management alternatives and potential areas of utilization, as described in Chapter 2. The major finding of this effort is that very little has been reported in the published literature addressing these topics, suggesting that aside from recycling, there are few established alternatives for the management of this material.

EPA has been able to establish that in 1988, iron producers reported that approximately 447,000 metric tons (36.3 percent) of the iron blast furnace APC dust/sludge was recycled to the beneficiation processes via the sinter plant and blast furnace, 750,000 metric tons (60.9 percent) was disposed of, and 34,000 metric tons (2.8 percent) was sold or sent off-site for further metal recovery.[46] It is believed that at least some of the APC dust/sludge which was sold or sent off-site, was probably used by zinc producers as a source of zinc.

Steel Furnace Slag

As discussed above, EPA does not expect that steel furnace slag would exhibit any of the four characteristics of hazardous waste (corrosivity, reactivity, ignitability, or EP toxicity). Consequently, the issue of how steel producers might modify their operations, waste management practices, or be stimulated to develop alternative uses for steel furnace slag in response to prospective hazardous waste regulation is not applicable. Any such operational changes that are currently contemplated by facility operators will therefore not be affected by EPA's actions, and hence, are beyond the scope of this Report to Congress. Nonetheless, in the following paragraphs, the Agency provides a brief summary of current and potential areas of steel furnace slag utilization.

In 1988, 24 of the 26 steel mills in the U.S. generated over 13.2 million metric tons of steel slag.[47] The primary management practices for steel furnace slag are recycling it to the blast furnace and processing it for use as an aggregate. In 1988, U.S. steel mills recycled approximately 1.8 million metric tons of steel slag.[48] A nationwide survey of slag processors conducted by the Bureau of Mines indicated that over 5.1 million metric tons of steel furnace slag was sold or used in the U.S. in 1988 at an average price of $3.16 per ton, ranging from an average of $2.44 when sold for railroad ballast to $4.55 when sold for asphaltic concrete aggregate.[49] The distribution of steel furnace slag among its various applications in 1988 is shown in Exhibit 8-12. The remaining 6.3 million metric tons of steel furnace slag was presumably stockpiled at either the generating facilities or at the slag processing facilities.

---

[44] Ibid., p. 2.

[45] Personal communication, Judith F. Owens.

[46] Company responses to the "National Survey of Solid Wastes from Mineral Processing Facilities," U.S. EPA, 1989.

[47] Production statistics for two facilities are confidential and not included in this total.

[48] Judith F. Owens, "Slag-Iron and Steel," Minerals Yearbook-1988, U.S. Department of the Interior, Bureau of Mines, 1988, p. 2.

[49] Ibid., p. 13.

Eleven years of Canadian testing and evaluation of 18 bituminous test sections of a major urban freeway showed that the most suitable mixtures for highways with high speed and heavy traffic are those containing steel furnace slag or traprock for course and fine aggregates. Findings such as this one may lead, in the future, to an expanding market for utilization of steel furnace slag as asphaltic concrete aggregate.[50]

Steel Furnace Air Pollution Control (APC) Dust/Sludge

As discussed above, EPA sampling data indicate that APC dust/sludge from steel furnaces may exhibit the hazardous characteristic of EP toxicity at some facilities. Accordingly, the Agency has conducted an intensive literature review of potential waste management alternatives and potential areas of utilization, as described in Chapter 2. The major finding of this effort is that very little has been reported in the published literature addressing these topics, suggesting that aside from recycling, there are few established alternatives for the management of this material.

EPA has been able to establish that in 1988, steel producers reported that approximately 57,700 metric tons (4 percent) of the APC dust/sludge was recycled to the beneficiation processes via the sinter plant and blast furnace, 646,000 metric tons (44.2 percent) was disposed of, and 757,500 metric tons (51.8 percent) was sold or sent off-site for further metal recovery.[51] It is believed that the APC dust/sludge that was sold or sent off-site was probably used by zinc producers as a source of zinc. It may also be that not much of the dust/sludge is recycled because of the presence of zinc and lead, both of which can cause problems in steel production.

Exhibit 8-12
Primary Uses of Steel Furnace Slag[52]

Road base	46%
Fill	25%
Asphaltic concrete aggregate	11%
Railroad ballast, ice control, soil conditioning	18%

8.6 Cost and Economic Impacts

Section 8002(p) of RCRA directs EPA to examine the costs of alternative practices for the management of the special wastes considered in this report. EPA has responded to this requirement by evaluating the operational changes that would be implied by compliance with three different regulatory scenarios, as described in Chapter 2. In reviewing and evaluating the Agency's estimates of the cost and economic impacts associated with these changes, it is important to remember what the regulatory scenarios imply, and what assumptions have been made in conducting the analysis.

The focus of the Subtitle C compliance scenario is on the costs of constructing and operating hazardous waste land disposal units. Other important aspects of the Subtitle C system (e.g., corrective action, prospective land disposal restrictions) have not been explicitly factored into the cost analysis. Therefore, differences between the costs estimated for Subtitle C compliance and those under other scenarios (particularly Subtitle C-Minus) are less than they might be under an alternative set of conditions (e.g., if most affected facilities were not already subject to Subtitle C, or if land disposal restrictions had been promulgated for "newly identified" hazardous wastes). The Subtitle C-Minus scenario represents, as discussed above in Chapter 2, the minimum requirements that would apply to any of the special wastes that are ultimately regulated as hazardous wastes; this scenario does not reflect any actual determinations or preliminary

[50] K.K. Tam, R. Raciborski, and D.F. Lynch, Ministry of Transportation of Ontario, Canada, "11 Years Performance of 18 Bituminous Test Sections on a Major Urban Freeway," prepared for presentation at the 1989 Transportation Research Board Annual Conference, January 22-26, 1989, Washington, D.C.

[51] Company responses to the "National Survey of Solid Wastes from Mineral Processing Facilities," U.S. EPA, 1989.

[52] Ibid.

judgments concerning the specific requirements that would apply to any such wastes. Further, the Subtitle D-Plus scenario represents one of many possible approaches to a Subtitle D program for special mineral processing wastes, and has been included in this report only for illustrative purposes. The cost estimates provided below for the three scenarios considered in this report must be interpreted accordingly.

In accordance with the spirit of RCRA §8002(p), EPA has focused its analysis on impacts on the firms and facilities generating the special wastes, rather than on net impacts to society in the aggregate. Therefore, the cost analysis has been conducted on an after-tax basis, using a discount rate based on a previously developed estimate of the weighted average cost of capital to U.S. industrial firms (9.49 percent), as discussed in Chapter 2. Waste generation rate estimates (which are directly proportional to costs) for the period of analysis (the present through 1995) have been developed in consultation with the U.S Bureau of Mines.

In this section, EPA first outlines the way in which it has identified and evaluated the waste management practices that would be employed by ferrous metal producers under different regulatory scenarios, developed the cost implications of requiring changes in existing waste management practices, and predicted the ultimate impacts of increased waste management costs associated with changes in the regulatory environment faced by iron and steel facility operators.

8.6.1 Regulatory Scenarios and Required Management Practices

Because the available data indicated that iron blast furnace slag and steel furnace slag pose low risks and do not exhibit any of the characteristics of hazardous waste, the issue of how waste management costs might change if Subtitle C regulatory requirements were applied and what impacts such costs might impose upon affected facilities is moot, and is not considered further in this report.

In contrast, based upon the information presented above, EPA concluded that both iron and steel APC dust/sludge could be subjected to regulation under Subtitle C absent the Mining Waste Exclusion. Waste composition data collected by EPA and submitted by facility operators indicate that these materials may exhibit characteristics of hazardous waste at some facilities, and the analysis of potential risk presented above demonstrates that the physical form and chemical characteristics of these materials, the management practices that are employed, and environmental settings in which waste management occurs could, in combination, impose risk to human health and the environment. Accordingly, the Agency has estimated the costs associated with such regulation, as well as with two somewhat less stringent regulatory scenarios, referred to here as "Subtitle C-Minus" and "Subtitle D" as previously introduced in Chapter 2, and as described in specific detail below.

In conducting its cost analysis, EPA has adopted the approach that only those iron and steel facilities that actually were sampled and whose waste(s) exhibited hazardous characteristics would be analyzed for regulatory compliance. The Agency assumed that APC dust/sludge at facilities that were not sampled would not exhibit the characteristic of EP toxicity; this assumption is based on the fact that wastes from the majority of the facilities sampled (and the great majority of the total number of samples) did not exhibit EP toxicity, and no damage cases involving these wastes were found (See Section 8.3.3.). The Agency's cost and impact analysis is therefore limited to five facilities: three facilities with potentially toxic APC residue from iron blast furnace operations and two facilities with potentially toxic APC residue from steelmaking operations. APC dust/sludge from these operations exhibited EP toxicity for selenium and/or lead.

Subtitle C

Under Subtitle C standards, generators of hazardous waste that is managed on-site must meet the rigorous standards codified at 40 CFR Part 264 for hazardous waste treatment, storage, and disposal facilities. Because the APC dusts and sludges are solid, non-combustible materials, and because under full Subtitle C regulation, hazardous wastes cannot be permanently disposed of in waste piles, EPA has assumed that the ultimate disposition of APC dust/ sludge would be in Subtitle C landfills that meet the minimum technology standards specified at 40 CFR 264. EPA has assumed that the affected facilities would continue to internally recycle the same quantity of dust/sludge as they do currently. The Agency has, however, assumed that the affected facilities would not continue to dispose their wastes off-site if the cost is higher than operating an on-site disposal landfill. The Agency has assumed that, in addition to the disposal units, the affected facilities would also construct a temporary storage waste pile (with capacity of one week's waste generation) that would enable the operators to send the dust/sludge to either on-site or recycling operations efficiently. This assumption reflects current practice, which often includes management in waste piles.

Subtitle C-Minus

A primary difference between full Subtitle C and Subtitle C-Minus is the facility-specific application of requirements based on potential risk from the hazardous special waste. Under the C-Minus scenario, as well as the Subtitle D-Plus scenario described below, the degree of potential risk of contaminating ground-water resources was used as a decision criterion in determining what level of protection (e.g., liner and closure cap requirements) will be necessary to protect human health and the environment. One of the five facilities of concern, US Steel/Fairless Hills, was determined to have a high potential to contaminate ground-water resources; the other four were determined to have a moderate groundwater contamination potential. The Fairless Hills facility, however, recycles its APC residue to the sinter/blast furnace operation and, therefore, operates no on-site disposal units; this mode of operation would continue under C-Minus. A second of the five facilities of concern, Sharon Steel's Farrell facility, currently disposes off-site; EPA's cost comparison analysis indicates that, under the C-Minus scenario, the facility would be likely to build an on-site disposal landfill. The remaining three facilities, all of moderate risk, dispose on-site in landfills or impoundments, none of which have liners that conform to the standards of this regulatory scenario. Therefore, each is assumed to build new disposal landfills containing a three foot clay liner and a protective fill layer. Each must also incorporate run-on/run-off controls and perform groundwater monitoring. In addition, the disposal units must undergo formal closure, including a cap of topsoil and grass over a composite liner. Post-closure care must be performed (e.g., leachate collection and treatment, cap and run-on/run-off control maintenance, and continued groundwater monitoring) for a 30 year period.

Subtitle D-Plus

As under both Subtitle C scenarios, facility operators would, under the Subtitle D-Plus scenario, be required to ensure that hazardous contaminants do not escape into the environment. Like the Subtitle C-Minus scenario, facility-specific requirements are applied to allow the level of protection to increase as the potential risk to ground water increases. The four facilities which dispose on-site (i.e., the Fairless Hills facility will continue to recycle) are assumed to build new disposal landfills with three foot clay liners and a protective fill layer. Each must incorporate run-on/run-off controls and perform groundwater monitoring. In addition, the disposal units must undergo formal closure, including a cap of topsoil and grass over a composite liner. Post-closure care must be performed (e.g., leachate collection and treatment, cap and run-on/run-off control maintenance, and continued groundwater monitoring) for a period of 30 years.

8.6.2 Cost Impact Assessment Results

Iron Blast Furnace APC Dust/Sludge

Regulatory compliance cost estimates for iron blast furnace APC dust/sludge are displayed in Exhibit 8-13. Of the 26 facilities operating iron blast furnaces in the ferrous metals production sector, only three are assumed to generate hazardous APC dust/sludge and, therefore, incur costs under the Subtitle C scenario: U.S. Steel at Fairless Hills, Pennsylvania; Bethlehem Steel at Sparrows Point, Maryland; and LTV Steel at East Cleveland, Ohio. Under the Subtitle C regulatory scenario, the annualized regulatory compliance costs would, respectively, be $68,000, $10.6 million, and $3.5 million greater than baseline waste management costs (76, 16, and 7 times larger than baseline costs, respectively). With the exception of the facility in Fairless Hills, the bulk of the compliance costs would be devoted to new capital expenditures. Specifically, the increase in annualized new capital expenditures for each facility would be $33,700 at Fairless Hills, $8.3 million at Sparrows Point, and $2.6 million at East Cleveland; increases in capital expenditures account for approximately 77 percent of the total annualized compliance costs for the sector. The majority of the prospective cost impact is attributable to the design and construction of the large Subtitle C landfills that would be required to manage this waste. The Fairless Hills facility has such low disposal costs because it utilizes (recycles) all of its air pollution control (APC) dust, so that its compliance activities would consist only of building an APC dust storage area (concrete pad) rather than a far more costly Subtitle C disposal landfill.

Under the facility specific risk-related requirements of the Subtitle C-Minus scenario, costs of regulatory compliance are, for the sector, about half of those under the full Subtitle C scenario. The annualized regulatory compliance costs for the Sparrows Point and East Cleveland facilities would be $4.6 and $1.6 million greater, respectively, than the baseline waste management costs (7 and 3 times larger than baseline). The cost savings of the Subtitle C-Minus scenario compliance over full Subtitle C costs result primarily from needing fewer liners and a less elaborate leachate collection system for the disposal landfill; capital costs are nearly 60 percent less under this scenario. Annualized compliance capital, however, continues to drive total costs, with capital costs making up approximately 68 percent of the total. The Subtitle C-Minus compliance costs for the Fairless facility would be nearly identical to its Subtitle C costs, since the technical requirements for a temporary storage area are the same under both scenarios.

Costs under Subtitle D-plus are expected to be virtually identical to those under Subtitle C-minus (different permit costs at the Fairless Hills facility are the only cost difference in the sector), as management practices are the same.

Steel Furnace APC Dust/Sludge

Regulatory compliance cost estimates for steel furnace APC dust/sludge are displayed in Exhibit 8-14. Of the 26 facilities operating steel furnaces in the ferrous metals sector, only two are assumed to generate hazardous waste and, therefore, incur costs under the Subtitle C scenario: U.S. Steel at Lorain, Ohio, and Sharon Steel at Farrell, Pennsylvania. Under the Subtitle C regulatory scenario, the annualized regulatory compliance costs would be $3.3 million and $2.3 million greater than the baseline waste management costs (9 and 3 times the baseline cost, respectively). The bulk of the annual compliance costs would be devoted to new capital expenditures; about 75 percent of the total cost is annualized capital costs, approximately $4.1 million for the two facilities combined.

Under the facility specific risk-based requirements of the Subtitle C-Minus scenario, costs of regulatory compliance are, for the sector, about 40 percent less than full Subtitle C costs. The annualized regulatory compliance costs for the Lorain and Farrell facilities would be $1.6 and 0.94 million greater than the baseline waste management costs, respectively (5 and 2 times larger than baseline). The cost advantage over the full Subtitle C regulations results primarily from needing fewer liners and a less elaborate leachate collection system for the disposal landfill.

Costs under Subtitle D-Plus re expected to be virtually identical to those under Subtitle C-Minus, as management practices are the same and no facilities are in low risk areas, the one condition that allows for differential landfill design and operating standards for the C-Minus and D-Plus scenarios.

8.6.3 Financial and Economic Impact Assessment

In order to evaluate the ability of the affected facilities to bear these estimated regulatory compliance costs, EPA conducted an impact assessment which consisted of three steps. First, the Agency compared the estimated compliance costs to the financial strength of each facility, to assess the relative magnitude of the financial burden that would be imposed in the absence of changes in supply, demand, or price. EPA also conducted a qualitative evaluation of the salient market factors which affect the competitive position of the iron and steel producers, in order to determine whether compliance costs could be passed on to labor, suppliers of raw materials, or consumers. Finally, the Agency combined the results of the first two steps to predict the net compliance-related economic impacts which would be experienced by the facilities being evaluated. The methods and assumptions used in this analysis are described in Chapter 2 and in a Appendices E-3 and E-4 to this report.

Financial Ratio Analysis

Iron Blast Furnace APC Dust/Sludge

Based on ratio analysis, EPA expects regulation under Subtitle C to have no significant impacts on the Fairless Hills facility, because its recycling operations circumvent the need for protective disposal operations. The impacts on the East Cleveland and Sparrows Point facilities, while not highly significant, are potentially significant; the Agency, therefore, has considered other factors such as market strength and ability to pass through costs. The financial ratios, as seen in Exhibit 8-15, are comparisons of annualized compliance costs to value of shipments and to total value added, and annualized compliance capital to annual sustaining capital investments; generally these ratios for the affected facilities fall within the one to five percent range.

The magnitude of financial impacts under Subtitle C-Minus and, identically, D-Plus regulation would be substantially less, though similar in distribution to those under full Subtitle C. For example, compliance cost as a percent of value added at the Sparrows point facility (the operation with the greatest impacts), falls from 4.2 percent under Subtitle C to 2.4 percent under the Subtitle C-Minus and D-Plus scenarios.

Steel Furnace APC Dust/Sludge

EPA believes that regulation under any regulatory scenario would have only marginal impacts on either facility generating steel furnace APC dust/sludge, as seen in Exhibit 8-16. Annual compliance costs as a percentage of either value of shipments or value added are less than one percent, indicating an absence of potentially significant impacts. Annualized compliance costs as a percentage of annual sustaining capital investments, typically a high ratio in affected sectors, is only 2-3 percent, even under full Subtitle C controls. For C-Minus and D-Plus scenarios this ratio is around one percent.

Market Factor Analysis

General Competitive Position

There have been extensive structural changes in the U.S. ferrous metals mining and processing industry since the recession of the early 1980s. Domestic producers have made a number of changes in the 1980's to make the overall iron and steel industry competitive on a worldwide basis. These included several steps:

1. Closure of high-cost mining operations and rationalization of iron ore production to a point where generally lower cost capacity is maintained;

Exhibit 8-15
Significance of Regulatory Compliance Costs for Management of APC Dust/Sludge from Iron Blast Furnaces[(a)]

Facility	CC/VOS	CC/VA	IR/K
Subtitle C			
LTV Steel - East Cleveland, OH	1.0%	2.6%	2.6%
Bethlehem Steel - Sparrows Point, MD	1.6%	4.2%	4.4%
U.S. Steel - Fairless Hills, PA	0.0%	0.1%	0.0%
Subtitle C-Minus			
LTV Steel - East Cleveland, OH	0.5%	1.2%	1.0%
Bethlehem Steel - Sparrows Point, MD	0.9%	2.4%	2.3%
U.S. Steel - Fairless Hills, PA	0.0%	0.1%	0.0%
Subtitle D-Plus			
LTV Steel - East Cleveland, OH	0.5%	1.2%	1.0%
Bethlehem Steel - Sparrows Point, MD	0.9%	2.4%	2.3%
U.S. Steel - Fairless Hills, PA	0.0%	0.1%	0.0%

CC/VOS = Compliance Costs as Percent of Sales
CC/VA = Compliance Costs as Percent of Value Added
IR/K = Annualized Capital Investment Requirements as Percent of Current Capital Outlays
(a) Values reported in this table are based upon EPA's compliance cost estimates. The Agency believes that these values are precise to two significant figures.
Costs and impacts have been estimated for only those facilities for which sampling data indicate that the waste exhibits a RCRA hazardous waste characteristic.

Exhibit 8-16
Significance of Regulatory Compliance Costs for Management of APC Dust/Sludge from Steel (BOF & OHF) Furnaces(a)

Facility	CC/VOS	CC/VA	IR/K
Subtitle C			
Sharon Steel - Farrell, PA	0.4%	0.7%	2.9%
U.S. Steel - Lorain, OH	0.3%	0.6%	1.9%
Subtitle C-Minus			
Sharon Steel - Farrell, PA	0.1%	0.3%	1.1%
U.S. Steel - Lorain, OH	0.2%	0.3%	0.7%
Subtitle D-Plus			
Sharon Steel - Farrell, PA	0.1%	0.3%	1.1%
U.S. Steel - Lorain, OH	0.2%	0.3%	0.7%

CC/VOS	=	Compliance Costs as Percent of Sales
CC/VA	=	Compliance Costs as Percent of Value Added
IR/K	=	Annualized Capital Investment Requirements as Percent of Current Capital Outlays
(a)	Values reported in this table are based upon EPA's compliance cost estimates. The Agency believes that these values are precise to two significant figures.	

Costs and impacts have been estimated for only those facilities for which sampling data indicate that the waste exhibits a RCRA hazardous waste characteristic.

2. Substantial capital investment at remaining facilities to lower costs per iron unit to a point at which domestically produced ore is competitive with ore delivered from oversees; and

3. Investments in iron and steel production process improvements at several mills throughout the U.S.

These changes in the U.S. steel industry structure have allowed the U.S. producers to move from the upper end to the middle end of the supply curve on a worldwide basis.

Potential for Compliance Cost Pass-Through

Labor Markets. Imposing substantially lower wages to counteract compliance costs is not a likely scenario in the ferrous metals industry. There have already been significant wage and benefit concessions and movement in the opposite direction with regard to wages is likely over the next few years.

Raw Material Supply Markets. As many of the U.S. mine supplies have become more cost-competitive, the possibilities of importing lower cost iron ore are declining. Also, the steel companies are partially integrated into ore production and are unlikely to achieve cost savings by ore price rollbacks or mine closures. The mines do provide a depletion allowance which can partially offset any imported ore price savings.

Higher Prices. The possibility of passing along higher prices in the steel industry is rather limited. The ferrous metals market is a world market and, therefore, U.S. prices must be in line with world prices. There are many producers of foreign steel with equal or lower costs than those of the U.S.; substantial price increases could therefore lead to increased imports. More importantly, EPA's data and analysis suggests that only five of the 28 ferrous metals facilities that produce iron and steel would experience increases in waste management costs in the absence of the Mining Waste Exclusion. It is extremely unlikely that these five facilities could successfully pass through compliance costs to domestic consumers given the structure of domestic and global iron and steel markets.

Evaluation of Cost/Economic Impacts

Only two of 28 facilities that generate iron/steel APC dust/sludge would face potentially significant economic impacts under any regulatory scenario. For the two affected facilities, however, the impacts would probably be marginally significant if operators continue to manage the material as a waste (i.e., not recycling to the sinter/smelter operation). The remaining 26 facilities in the primary ferrous metals processing sector will probably not suffer significant impacts if any of the four special wastes (i.e., including slag) generated within the ferrous metals sector were to be removed from the Mining Waste Exclusion. EPA emphasizes, however, that these results are based upon limited waste characterization data; if additional facilities that were not sampled generate EP toxic waste(s), then the costs and impacts predicted here would be underestimates of the true magnitude of regulatory impacts.

Due to the international nature of the market for ferrous metals, U.S. producers would be unlikely to be able to raise prices enough to pass through compliance costs. The Sparrows Point facility might be able to use feedstock cost advantages (related to its coastal location, allowing for lower feedstock transportation costs through use of ocean transport) to recover compliance costs, though recent losses across the industry as a whole have left most facilities with very narrow profit margins. The East Cleveland facility, with its owner/operator (LTV Steel) already in financial difficulties (i.e., having filed for bankruptcy), would be hard pressed to absorb additional regulatory compliance costs and raise new capital for compliance-related investments. The Agency points out, however, that recycling of the waste at these facilities, if technically feasible (at least ten generators of iron blast furnace APC residue recycle all or some of the waste to sinter/smelter operations), would result in neither facility incurring any significant impacts under any regulatory scenario.

As a final note, the Agency emphasizes that some cost and economic impacts would be likely to occur even if the wastes are retained within the Mining Waste Exclusion, because adequately protective standards under an eventual Subtitle D program would probably require the construction of new disposal units at most plants, as reflected by the Subtitle D-Plus scenario presented here.

8.7 Summary

As discussed in Chapter 2, EPA developed a step-wise process for considering the information collected in response to the RCRA §8002(p) study factors. This process has enabled the Agency to condense the information presented in the previous six sections of this chapter into three basic categories. For each special waste, these categories address the following three major topics: (1) potential and documented danger to human health and the environment; (2) the need for and desirability of additional regulation; and (3) the costs and impacts of potential Subtitle C regulation.

Iron Blast Furnace and Steel Furnace Slag

Potential and Documented Danger to Human Health and the Environment

The intrinsic hazard of iron blast furnace and steel furnace slags is relatively low compared to other mineral processing wastes studied in this report. These wastes do not exhibit any of the four characteristics of hazardous waste. Review of the available data on blast furnace and steel furnace slag solid samples and leachate constituent concentrations indicates that only seven constituents are present at concentrations greater than 10 times the conservative screening criteria used in this analysis. In blast furnace slag, concentrations of manganese, iron, lead, arsenic, and silver exceed screening criteria by more than a factor of 10. Concentrations of manganese, iron, chromium, thallium, and arsenic in steel furnace slag exceed one or more of the conservative screening criteria in one or more samples by more than a factor of 10. In addition, aqueous extracts of both blast furnace and steel furnace slag are highly alkaline (pH up to 11.7). These exceedances indicate the potential for the slags to pose risks under very conservative, hypothetical exposure conditions. The actual exposure conditions at the active facilities, however, are not as conducive to human health or environmental damage as those upon which the screening criteria are based, in large part because the slags consist of large solid fragments that are not easily dispersed, and from which contaminants are not readily released. These findings lead EPA to conclude that the intrinsic hazard of these slags is relatively low.

Based on a review of the site-specific conditions at 11 facilities, the potential for blast furnace and steel furnace slag to cause significant impacts appears low at most of the active facilities. The potential for significant releases to ground water is often limited by a low net recharge and a large depth to ground water. The potential for significant surface water impacts is limited by the large particle size of the slag (which precludes erosion) as well as the large distances to water bodies, large surface water flow rates, and great downstream distances to potential receptors at many sites. The large particle size of the slag also limits the potential for significant airborne releases.

This overall low-risk conclusion is supported by the general lack of documented cases of damage attributable to the slags. Even though the slags have been generated and managed at many sites for several decades, EPA identified only one damage case and that case is associated with an inactive facility that was operated under rather unusual conditions. EPA believes that the management controls and environmental conditions at a few of the active facilities are, in theory, also favorable for contaminant releases to ground and surface water, but no releases attributable to the slags are known to have occurred at these sites in the past.

Likelihood That Existing Risks/Impacts Will Continue in the Absence of Subtitle C Regulation

The conditions that currently limit the potential for significant threats to human health and the environment are expected to continue to limit risks in the future in the absence of more stringent federal regulation. The character of the waste is not expected to change and no new blast furnace or primary steel furnace facilities are expected to be constructed in the near future. The slags are widely used at off-site locations, which conceivably could be conducive to releases and risks at present and in the future. However, based on the paucity of documented cases of damage from blast furnace and steel furnace slag, EPA believes that the conclusion of low hazard can be extrapolated to off-site locations of slag disposal or use and to other locations where slag might be used in the future.

Both iron blast furnace slag and steel furnace slag are processed, sold, and used extensively for a variety of purposes, such as road base material, fill, asphaltic concrete aggregate, and railroad ballast. Consequently, both types of slag, particularly iron slag, are often handled as commodities rather than wastes. Ongoing research efforts suggest that new processing technologies will allow the use of slag for additional purposes, which would further reduce the quantity of ferrous metal slag requiring disposal.

State regulation of blast furnace and steel furnace slag is similar in the five states that were reviewed for purposes of this report. For the most part, the states exempt slag from regulation when it is reprocessed or stored temporarily (i.e., not disposed permanently). Iron and steel slag management, therefore, generally is not subject to solid waste (or other land-based) regulation in any of these states, though in some cases waste slag is disposed of in a permitted landfill. Slags that are disposed of permanently on-site or sent off-site to an approved landfill are generally subjected only to minimal requirements (e.g., covers, run-on/run-off controls). As with solid waste regulation, the application of water regulations (i.e., state and/or federal NPDES requirements) to slag wastes generally is not extensive, though it varies considerably from state to state and facility to facility. Moreover, with few exceptions, the states are imposing only minimal, if any, fugitive dust controls on slag waste piles. The management of these slags under solid waste regulations, however, is likely to change dramatically in the near future. Four of the five study states are in the process of proposing or implementing new waste regulations which would address these materials, while the fifth state recently enacted new ground-water protection legislation. Presumably these new regulations will result in more comprehensive and stringent management and disposal practices, though the extent to which this is likely to happen is unclear.

Costs and Impacts of Subtitle C Regulation

Because of the low risk potential of iron and steel slags, the general absence of documented damages associated with these materials, and the fact that iron and steel slags do not exhibit any characteristics of hazardous waste, EPA has not estimated the costs and associated impacts of regulating iron and steel slags under RCRA Subtitle C.

Iron and Steel Air Pollution Control Dust/Sludge

Potential and Documented Danger to Human Health and the Environment

The intrinsic hazard of blast furnace and steel furnace APC dust/sludge is generally moderate to high in comparison with the other mineral processing wastes studied in this report. Based on EP leach test results of blast furnace APC dust/sludge, 4 out of 70 samples (from 3 out of 16 facilities tested) contain lead concentrations in excess of the EP toxicity regulatory levels. Selenium was also measured in EP leachate of blast furnace and steel furnace APC dust/sludge in concentrations that exceed the regulatory level in 1 out of 64 samples of blast furnace APC dust/sludge and 1 out of 7 samples of steel furnace APC dust/sludge. Moreover, blast furnace APC dust/sludge contains 12 constituents at concentrations that exceed one or more of the conservative screening criteria used in this analysis by more than a factor of 10. In steel furnace APC dust/sludge, the concentrations of eight constituents exceed one or more of the conservative screening criteria by more than a factor of 10. In addition, aqueous extracts of both blast furnace and steel furnace APC dust/sludge are highly alkaline (pH up to 12.5). While releases and exposures are generally not expected to be as large as the hypothetical conditions upon which the screening criteria are based, the dusts/sludges consist of small particles that are prone to environmental release and transport when not properly controlled.

Based on an examination of the site-specific conditions at 17 facilities, the current management of blast furnace and steel furnace APC dust/sludge poses a low threat at some facilities but a moderate to high threat at others. In general, the potential for the dust/sludge to cause significant ground-water impacts is limited at most sites that manage the waste in a dry form (in stockpiles, landfills, waste piles, etc.) because of the low net recharge, depth to ground water, and/or distance to potential receptors. When managed in impoundments, however, there is a considerably greater potential for the dust/sludge contaminants to migrate into ground water. EPA believes that the potential for the dust/sludge contaminants to migrate into surface water is high at 13 of the facilities because of the wastes' small particle size, a lack of engineered controls to limit releases, and a close proximity to surface water bodies. However, contaminants entering rivers near all but four of these facilities are likely to be readily assimilated by the rivers' large flow. Considering the susceptibility of the dust/sludge to wind erosion, the exposed surface area of waste management units, the lack of dust suppression controls, atmospheric conditions, and population distributions, there is also a relatively high potential for airborne releases and exposures at seven facilities. Despite these theoretical conclusions about potential hazards, EPA did not identify a single case of environmental degradation that can be attributed to the dust/sludge. Therefore, considering the site-specific conditions together with the lack of damage cases, EPA concludes that the dusts/sludges pose an overall moderate risk.

Likelihood That Existing Risks/Impacts Will Continue in the Absence of Subtitle C Regulation

As discussed above, APC dust/sludge waste management practices and environmental conditions at a number of iron and steel production facilities may allow contaminant releases and moderate risks. Continuation of current management practices in the absence of more stringent federal regulation will continue to pose risks to human health and the environment from APC dusts/sludges into the future. For example, only 1 of the 5 facilities evaluated in this analysis that manages these wastes in impoundments utilizes engineered controls such as liners or leachate collection systems to restrict releases to ground water. Similarly, although the dust is susceptible to wind erosion, only 8 of the 15 facilities that manage dust in landfills or waste piles practice any dust suppression measures. Therefore, environmental releases can occur and, considering the intrinsic hazard of the dust/sludge, significant exposures could occur if affected ground water is used as a source of drinking water.

In addition to the potential impacts at the facilities evaluated in this analysis, threats to human health and the environment may occur at other locations now and in the future as a result of off-site disposal of APC dust/sludge. For example, five facilities reported that they sent all their blast furnace APC dust/sludge off-site for disposal in 1988, and although risks from these off-site locations have not been evaluated in detail because of a lack of site-specific information, it is likely that dust/sludge management at some of these locations may present threats to human health or the environment. The production of steel has increased steadily in recent years, though future growth in demand is expected to be moderate. EPA believes that much of this future demand will be met by mini-mills (which utilize secondary materials and do not generate special wastes) rather than by the addition of new blast furnace or steel furnace facilities.

The management and disposal of APC dust and sludge are, to a large extent, not being addressed under solid waste regulations by the five states reviewed for this report, though these wastes are landfilled by facilities in at least two states and are therefore subject to all pertinent regulations governing landfills. APC dust and/or sludge that is disposed of permanently on-site or sent off-site to an approved landfill generally is subjected only to minimal requirements (e.g., covers, run-on/run-off controls). As with solid waste regulations, the application of water regulations (i.e., state and/or federal NPDES requirements) to APC dusts and sludges generally is not extensive, though it varies considerably from state to state and facility to facility. Moreover, with few exceptions, the states are imposing only minimal, if any, fugitive dust controls on APC dust/sludge waste piles. The management of these wastes under solid waste regulations, however, is likely to change dramatically in the near future. Four of the five states studied for this report are in the process of proposing or implementing new waste regulations that would address these materials, while the fifth state recently enacted new ground-water protection legislation. Presumably these new regulations will result in more comprehensive and stringent management and disposal practices, though the extent to which this is likely to happen is unclear.

Costs and Impacts of Subtitle C Regulation

EPA has evaluated the costs and associated impacts of regulating iron blast furnace APC dust/sludge and steel furnace APC dust/sludge as hazardous wastes under RCRA Subtitle C. EPA's waste characterization data indicate that these materials may exhibit the hazardous waste characteristic of EP toxicity at three and two facilities, respectively.

Because neither of these wastes exhibited hazardous characteristics at the majority of facilities that were sampled and because there were only a small total number of EP toxicity test exceedances, EPA assumed that these wastes would not exhibit characteristics (and hence, be subject to regulation in the absence of the Mining Waste Exclusion) at facilities that were not sampled. For iron blast furnace APC dust/sludge, costs of regulatory compliance under the full Subtitle C scenario range from $68,000 per year at the Fairless Hills facility (which recycles its dust) to more than $10 million annually at Bethlehem's Sparrows Point plant; these costs might impose potentially significant economic impacts on the operators of two of the three affected plants. For steel furnace APC dust/sludge, Subtitle C compliance would result in incremental costs of about $2.3 million and $3.3 million at the two affected facilities. Application of the more flexible Subtitle C-Minus regulatory scenario would result in compliance costs that are approximately 55 percent lower. Costs under the Subtitle C-Minus and Subtitle D-Plus scenarios are similar (or identical) at all three affected iron facilities and both affected steel plants, because adequately protective waste management unit design and operating standards are essentially the same under both scenarios, given the nature of the waste and the environmental settings in which it is currently managed.

Costs of full Subtitle C compliance would comprise a potentially significant fraction of the value of shipments of and value added by one affected iron producer (Sparrows Point). Compliance costs at the other four ferrous metals facilities are moderate or low, based upon the Agency's screening criteria. Under the less stringent Subtitle C-Minus scenario, compliance costs are not likely to impose significant impacts on any of the affected facilities. Given the modest nature of the prospective cost impacts of modified Subtitle C and Subtitle D regulation, and the relatively healthy position of domestic ferrous metals producers, EPA does not believe that potential regulatory compliance costs under RCRA Subtitle C would impose significant economic impacts upon affected facilities. These costs would not be shared among all domestic producers (affected facilities account for approximately 13 percent of domestic iron capacity, and seven percent of carbon steel capacity), and therefore, affected facilities may be put at a competitive disadvantage with respect to other domestic producers. Nevertheless, the Agency does not believe that the long-term profitability and continued operation of these plants would be threatened by a decision to regulate either iron or steel APC dust/sludge under Subtitle C.

In addition, it is worthy of note that these impacts would be likely to occur even in the absence of a decision to remove the air pollution control wastes from the Mining Waste Exclusion, because adequately protective waste management standards under a Subtitle D program would require the construction of new waste management units at most plants, implying significant new capital expenditures.

Finally, EPA believes that no significant disincentives for recycling or utilization of the APC dusts and sludges would be created if a change in the regulatory status of these wastes were to occur. Recycling is currently the predominant alternative to disposal that is applied to these materials. It is possible that tighter regulatory controls on the management of APC dust/sludge might serve to promote even greater recycling than has occurred in the recent past (approximately 36 percent of iron APC dust/sludge was recycled in 1988). Utilization of the dusts and sludges has not been widely reported, though limited quantities of iron blast furnace APC dust/sludge were sold for metal recovery (zinc) in 1988. It is not likely that removing iron blast furnace or steel furnace APC dusts/sludges from the Mining Waste Exclusion and thereby subjecting them to regulation as hazardous wastes would significantly limit or prevent this practice.

Exhibit 8-13
Compliance Cost Analysis Results for Management of APC Dust/Sludge from Iron Blast Furnaces[(a)]

Facility	Baseline Waste Management Cost	Incremental Costs of Regulatory Compliance								
		Subtitle C			Subtitle C-Minus			Subtitle D-Plus		
	Annual Total ($ 000)	Annual Total ($ 000)	Total Capital ($ 000)	Annual Capital ($ 000)	Annual Total ($ 000)	Total Capital ($ 000)	Annual Capital ($ 000)	Annual Total ($ 000)	Total Capital ($ 000)	Annual Capital ($ 000)
LTV Steel - East Cleveland, OH	609	3,489	17,245	2,573	1,625	6,748	1,007	1,625	6,748	1,007
Bethlehem Steel - Sparrows Point, MD	692	10,591	55,852	8,334	4,626	22,013	3,285	4,626	22,013	3,285
U.S. Steel - Fairless Hills, PA	1	68	226	34	68	226	34	60	226	34
Total:	1,302	14,148	73,323	10,941	6,318	28,987	4,325	6,310	28,987	4,325
Average:	434	4,716	24,441	3,647	2,106	9,662	1,442	2,103	9,662	1,442

Costs have been estimated only for facilities for which sampling data indicate that the waste would exhibit a RCRA hazardous waste characteristic.

(a) Values reported in this table are those computed by EPA's cost estimating model, and are included for illustrative purposes. The data, assumptions, and computational methods underlying these values are such that EPA believes that the compliance cost estimates reported here are precise to two significant figures.

Exhibit 8-14
Compliance Cost Analysis Results for Management of APC Dust/Sludge from Steel (BOF & OHF) Furnaces[(a)]

Facility	Baseline Waste Management Cost	Incremental Costs of Regulatory Compliance								
		Subtitle C			Subtitle C-Minus			Subtitle D-Plus		
	Annual Total ($ 000)	Annual Total ($ 000)	Total Capital ($ 000)	Annual Capital ($ 000)	Annual Total ($ 000)	Total Capital ($ 000)	Annual Capital ($ 000)	Annual Total ($ 000)	Total Capital ($ 000)	Annual Capital ($ 000)
Sharon Steel - East Cleveland, OH	963	2,342	12,993	1,939	936	5,100	761	936	5,100	761
U.S. Steel - Lorain, OH	413	3,341	14,717	2,196	1,680	5,365	801	1,680	5,365	801
Total:	1,376	5,683	27,710	4,135	2,616	10,465	1,562	2,616	10,465	1,562
Average:	688	2,841	13,855	2,067	1,308	5,232	781	1,308	5,232	781

Costs have been estimated only for facilities for which sampling data indicate that the waste would exhibit a RCRA hazardous waste characteristic.

(a) Values reported in this table are those computed by EPA's cost estimating model, and are included for illustrative purposes. The data, assumptions, and computational methods underlying these values are such that EPA believes that the compliance cost estimates reported here are precise to two significant figures.